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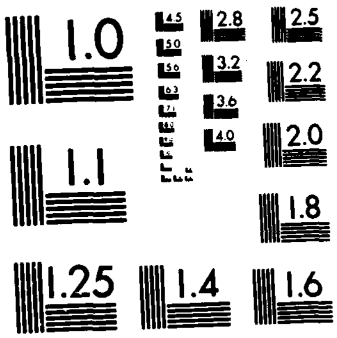

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CONCEPTS EVALUATION MODEL V

INPUT-DATA SYSTEM

THESIS

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CONCEPTS EVALUATION MODEL V
INPUT-DATA SYSTEM

THESIS

Presented to the Faculty of the School of Engineering
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Master of Science

by
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Preface

The purpose of this thesis investigation was to analyze the processes and operations involved in the development of the Threat Force File and to design a series of subject databases to support the simulation model used by the United States Army Concepts Analysis Agency. A structured methodology provided the frame work for realization of results from each activity.

The systems analysis of the Threat Force File development process was done with the intent of identifying areas where information management techniques could be applied to improve system efficiency. The logical database designs were based upon the needs of the major USACAA study teams for the timely retrieval of specific information items from the model's output.

I extend my deepest thanks to the members of the Data Systems Team: Mr. F. Womack, Ms. B. Knox, and Ms. M. McPadden for their professional assistance and technical expertise during the on-site research portion of this thesis effort. Highest commendations and sincerest appreciation goes to LTC John M. Deems, Chief, Data Systems Team, and thesis sponsor. LTC Deems's limitless enthusiasm and extensive knowledge in the field of data processing was the cornerstone for this aspect of my graduate education. Finally, I would like to thank my thesis committee: MAJ M. R. Varrieur (Thesis Advisor), Dr. H. Potoczny, and Maj C. Lillie for their support and guidance during this time.

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Abstract

A systems analysis was performed on the Threat Force File development process used in conjunction with the Concepts Evaluation Model (CEM V) at the United States Army Concepts Analysis Agency. Additionally, logical subject databases were designed to facilitate the retrieval of specific information from the output generated by the CEM V. A systematic approach provided the focus for resolution of each activity.

The resulting systems analysis documents the activities and processes that the agency's four major study teams go through in preparing the Threat Force File for input to the CEM V. Areas were identified for application of data management techniques to improve system efficiency.

The database designs resulted from the application of techniques selected from existing design methodologies. The logical schemas were transformed into network structures consistent with the database management system (DMS-1100) used by USACAA.

I. Introduction

Background

The United States Army Concepts Analysis Agency (USACAA), located in Bethesda, Maryland, is responsible to the director of the Army Staff (ARSTAFF) for analytical studies that illuminate and surface major issues affecting the size and composition of future Army forces. Some of the larger analytical efforts under the direction of USACAA make use of a computer simulation model known as the CONCEPTS EVALUATION MODEL (CEM V). This study tool provides information on the various aspects of war fighting in a simulated environment. The model is provided data from numerous sources, both internal and external to USACAA.

Each individual study team at USACAA creates its own study files using whatever collection of manual and/or automated processes that the particular team has developed over the recent years. The current policy of USACAA allows the study teams access to any available and authorized sources in obtaining the necessary data to support the specific study effort. Analysts involved may consult established USACAA subject databases for all or part of the needed data. There does not exist a consolidated system which incorporates all these diverse informational elements. Normally, the teams do not share their data, nor is there any centralized control over the input [illegible] is used. Additionally, there has been no effort to statistically analyze the data being put into the Concepts Evaluation Model by the different study teams.

As the complexity and cost for undertaking major long term study efforts increase, the need for a more responsive and efficient information processing system is of extreme importance. An area of primary interest to USACAA is the feasibility of applying database/information management technology and concepts in a manner that would incorporate all of the individual study teams' data processing requirements into one centralized processing environment. Careful analysis of the existing information management process followed by systematic application of applicable data management techniques can lessen the users data acquisition time, decrease redundancy, improve data integrity, and upgrade the overall data processing efficiency.

Problem Statement

The purpose of this thesis investigation was twofold; the first portion of the effort was directed towards a precise definition and documentation of the data gathering/processing phases that the individual study teams followed in development of the THREAT FORCE FILE. This file, when integrated with other required files, constituted the CEM V input deck. Because these teams were allowed access to data from whatever source was deemed applicable, a large amount of data redundancy was encountered. Additionally, problems in the area of data consistency and integrity were prevalent due to the lack of control and management of the vast amount of information required to support the model.

The second portion of this research effort was devoted towards an investigation of the output file generated by the CEM V simulation model. The objective here was to ascertain users' comments about the output and include it with the information gained from the Threat Force File analysis to provide useful changes to a future version of the Concepts Evaluation Model. Particular interest in this area was the possibility of downloading the output file from a particular model run into a series of subject databases whereby DML commands could be used to retrieve specific data information. Previous problems had been encountered with the voluminous amount of information in the reports generated from a CEM V run. It was not uncommon to see thousands of pages of computer printouts which the study analysts had to sift through in order to arrive at their conclusions and recommendations. The proposed designs become the foundation for support of user processing applications as well as on-line transactions utilizing the DMS-1100 database management system and its associated Query Language Processor. An additional requirement existed: for any logical database designs developed, they had to be further defined for compatibility with the specific DBMS in use at USACAA.

Scope

This thesis investigation focused on the data processing activities of four major individual study teams within USACAA: 1) TAA (TOTAL ARMY ANALYSIS), 2) OMNIBUS (US ARMY OPERATIONAL READINESS ANALYSIS, 3) IDOFOR (IMPROVING THE DEFINITION OF

THE OBJECTIVE FORCE), and 4) RQ (REQUIREMENTS). Areas which were examined during the course of this work included the existing physical and logical data processing system in current use by these study teams, the types of data involved along with the complexity of their corresponding relationships, data structures, determination and specification of the individual study team's views of the data, the data processing requirements (both present and future), and lastly, the generic representation of the data as viewed by the study teams. As this investigation was concerned with analysis and application of a wide diversity of information management concepts, the physical implementation of designs was not addressed.

Approach

The initial phase of this research effort consisted of a literature search for information on logical database design and the definition of systems requirements through the use of structured analysis. In addition, time was devoted towards familiarization with the DMS-1100 (DBMS used at USACAA).

In defining the existing data processing environment for development of the Threat Force File, the concepts of systems analysis were rigorously followed. Through the use of data flow diagrams, the current physical and logical data processing system of each study team was modeled. Once these procedures had been obtained and verified for accuracy with the respective users, it was necessary to determine the existing logical data flow. This aspect attempted to incorporate all the individual processes and abstract the results so that

understanding of the specific physical activities was not necessary. Once this was accomplished, it became necessary to specify the proposed logical system. This document provided the agency with a view from which the data collection/development process could be brought under control and managed so as to minimize the problems of redundancy and improve data integrity. Additionally, the system description identified those areas that could be considered for consolidation so as to reduce excessive duplication of effort when needed information was obtained.

Approaching the second portion of this thesis investigation required careful adherence to a systematic database design strategy. The goal was to select several logical database design strategies, to discuss the relative merits of each, and to select those techniques which seemed most applicable to the problem in question. Emphasis was placed upon the collection of data information and the associated analysis. Data entities and attributes were obtained, relationships between entities were established, and preliminary schema designs were undertaken. Due to the presence of a current DBMS (DMS-1100), it was required to define schema designs in terms of the network model so as to provide timely availability of research information. An analysis of the resulting designs was done to determine database size and transport volume. This analysis provided an aid for decisions regarding future refinements or alterations of the logical designs to more effectively meet the information needs of USACAA.

Thesis Organization

The second chapter discusses the aspects of systems analysis and how these techniques were applied to the description of the development/preparation of the Threat Force File.

Chapter Three addresses and defines those aspects and concepts of logical database design that are relevant to the understanding of this work. Attention is directed towards data collection/analysis, determination of the data processing requirements, specification of the logical databases without regard to data-model requirements, and lastly, determination of data-model specific logical databases. Additionally, an evaluation of several existing logical database design strategies is provided.

The fourth chapter concentrates on the use of the systematic design strategy in the structuring of the CEM V output file into logical database designs and development of the network specific schemas.

The concluding chapter presents recommendations and conclusions steming from this thesis investigation. Areas and problems worthy of future study are also noted.

II. Systems Analysis and the Threat Force File Development

Introduction

Preparation of the input deck to the Concepts Evaluation Model requires a number of individual files to be generated, updated, and integrated to meet the model's operating requirements. The Threat Force File was one specific file that was identified by USACAA's Data System Team as a worthy candidate for a systems analysis.

Under the current policy at USACAA, each study team is allowed to prepare its own input deck; hence, individual Threat Force Files, are developed for each different study. A large effort is undertaken at the beginning of each study to gather information and data necessary to produce this file. By multiplying this collection effort by the number of the study teams involved, one can conceive of problems in the area of data redundancy, integrity, and duplication of effort. In addition, a problem of documentation exists with the multiple sources for the file information, compounding the problems of redundancy and integrity. In order to fully understand the process that went into preparation of the Threat Force File, the first portion of this investigation concentrated on the definition and documentation of the data collection/file development process followed by USACAA's four major study teams: OMNIBUS (US Army Operational Readiness Analysis), RQ (Requirements), TAA (Total Army Analysis), and IDOFOR (Improving the Definition of the Objective Force).

Following from this work, areas were identified where overlap existed for possible consolidation or application of data management techniques to relieve or reduce those previously discussed problems.

For the purposes of this portion of the thesis investigation; the definition of systems analysis is defined as:

> "... the examination of problems, objectives, requirements, priorities, and constraints in an environment, plus identification of cost estimates, benefits and time requirements for tentative solutions." (Ref 18:13)

Figure 1 describes the interaction between the systems analysts and the users in defining requirements and developing system specifications.

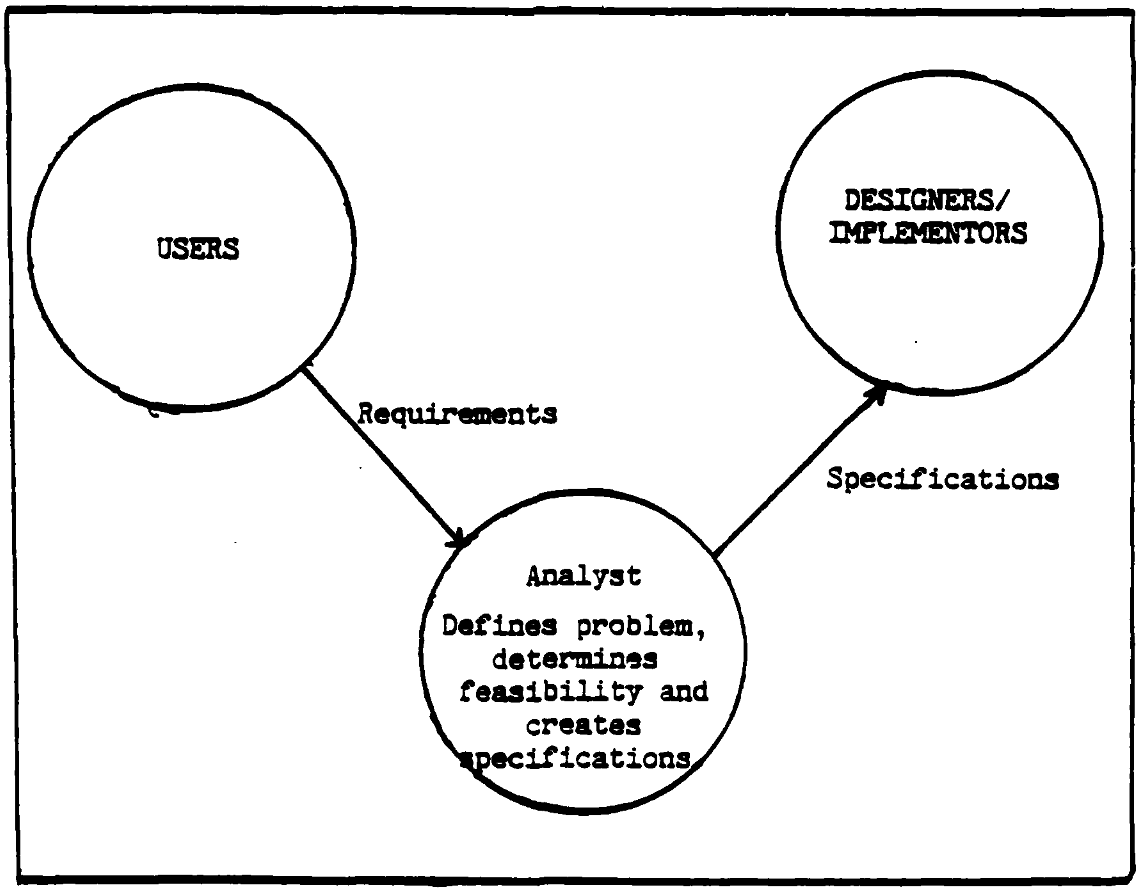

Figure 1. Systems Analyst Role (Ref 18:13)

In order to proceed with a systems analysis of the Threat Force File development process, the need for a systematic approach to the work was a necessity. The careful application of the structured methodology, as proposed by Weinberg (Ref 18:279-303), helped to maintain the focus of the analysis and to direct the effort towards an accurate representation of the processes involved. This methodology was selected over the Structured Analysis Design Technique (SADT) because of the holistic view towards systems description and modeling embodied in the structured methodology. The emphasis placed on data flow diagrams as a graphical communications medium provided a simple and direct method for interacting with interested parties.

Concepts of Structured Methodology

Structured methodology is a systematic approach to the development and maintenance of systems (Ref 18:279). It provides a blueprint for keeping the analysis activity on course and free of tempting distractions which pay little benefit yet require the expenditure of precious time resources. Structured methodology encompasses several techniques to focus the development effort. As their names imply, structured analysis, structured design and structured programming, take a pragmatic view of the system under study.

Weinberg provides the potential systems analyst with nine phases to cover all the aspects of system analysis from the conceptual formulation to the maintenance of the finished product. These phases are: 1) Request Evaluation,

2) Systems Survey/Feasibility, 3) Objectives and Priorities Definitions, 4) Physical Alternatives Definition, 5) Detailed Logical Design, 6) Top-Down Implementation Plan, 7) Detailed Physical Design, 8) Top-Down Implementation and 9) Post Evaluation. The scope of this portion of the thesis will be limited to a discussion of the first three phases as they are the key to understanding the following section.

The "Request Evaluation" phase is the initial attempt to identify and document a current or potential problem of interest to some organization or set of users. The principle item, which the analyst focuses on during this time, is the problem definition. Key questions are: What is the problem and what is the history behind the problem? An analyst must look at the problem's environment to ascertain internal/ external sources which affect the problem, the organizational involvment, and any limiting constraints. Lastly, the analyst must attempt to determine the effects of the problem on the organization itself.

Phase 2, the "Systems Survey/Feasibility" portion of the methodology, attempts to take the information gathered previously and make an initial assessment as to the feasibility of solving the problem. During this time an effort is made to model the existing system. Through the use of graphical tools, such as data flow diagrams, the analyst attempts to capture an accurate description of the way the systems works. This piece of documentation allows the analyst to convey initial impressions of the problem, its environment,

personnel involvement, and problem impact to the users for verification of accuracy. This is the point at which the analyst discovers "how business is done." If the situation and its corresponding description are not totally accurate, the analyst merely repeats the cycle until there is agreement among users that the modeled system is correct.

The last phase for discussion in the concepts area is the "Objectives and Priorities Definition". Following from the previous phase, this activity takes that information and attempts to synthesize it into a logical representation of the situation. The goal here is to remove physical references to the system and problem so as to minimize the need for technical expertise in grasping the complexities of the system's logical requirements. This is extremely important to the user who is not versed in the technical jargon of the problem but is involved in the decision process. Once the logical portrayal of the system has been established, the analyst can direct the focus of attention from the current to the proposed system environment. While an actual physical solution is not derived at this point, the groundwork is prepared for its future creation. As before, data flow diagrams serve as important communication devices in relating the analyst's views to those of the users. Less ambiguity is encountered with the use of diagrams and pictures than through the use of narrative prose.

The remaining phases of Weinberg's methodology are important to overall system development. Because they are not

addressed in regard to this work, it should not be construed that these phases are unimportant or optional. Due to the limited scope of this portion of the thesis investigation, only the first three phases are applicable to the obtained results. The following section takes those pertinent phases and demonstrates their application to the analysis of the Threat Force File development process.

Threat Force File Development

Request Evaluation. Information needed to develop Weinberg's Phase 1 was obtained, for the most part, prior to on-site research at USACAA. The Chief of the Data Systems Team articulated the perceived problems with the data collection process across the entire spectrum of the CEM V input file preparation. It was not until after arrival at USACAA that the analysis portion of this part of the thesis investigation was narrowed to the specific development of the Threat Force File.

The initial problem statement that was generated during this phase was to precisely define and document the data gathering/processing activities undertaken by the four major study teams in preparing the Threat Force File. Historically, the teams had collected needed information as independent organizational groups. There was very little sharing of information or means for processing that information such as common file utilities. Additionally, each team had its own developed sources from which to obtain the desired data.

With this background, the process of quantifying the impact of the problem was straightforward. Much of the data collected was redundant, thereby introducing integrity problems and "staleness" (not the most current information). Also, a large amount of time and effort was being devoted by the agency's analysts to gather this data, sometimes at the expense of its own output analysis activity. Hence, duplication of effort consumed many unnecessary work hours.

Constraints involved with the problem centered mainly on the distributed approach to data collection. The policy in effect during this time allowed the study analysts access to whatever data sources were applicable to retrieve the required information. There was no evidence of any agency standards or established procedures for this type of activity except for those implied guidelines developed witin the respective teams.

The beginning days of the on-site research time centered on unstructured interviews of the various study team members and other interested parties to confirm the intitial problem specification. The information gained helped to build the framework for the following two phases. The approach of unstructured interviews in the beginning aided in establishing rapport and understanding between the involved parties. It also allowed for the free exchange of views without restricting comments to specific details. This approach provided a basis for the formulation of structured interviews which characterized the "Systems Survey/Feasibility" phase of the analysis.

Systems Survey/Feasibility. Phase 2 of Weinberg's structured methodology proved to be one of the most time consuming aspects of the on-site research activity conducted at USACAA. This phase can best be portrayed as an interative process of system description followed by user verification. In this case, the system to be described was the Threat Force File preparation process. The problem inherent to the system, centered on the data collection activity previously discussed. The objective of this phase was to develop a set of physical data flow diagrams for each major study team which expressed the existing way the Threat Force File was developed.

Prior to diagramming each study team's system, structured interviews were conducted with the intent of focusing the thoughts strictly on the process followed to complete the file's preparation. It was established from the onset of each exchange that a structured interview should maintain the focus of the interaction, serve to isolate the needed data, and preclude the loss of valuable time due to tangents and "nice-to-know" information. This approach worked well and was received enthusiastically as the majority of personnel involved had many things of much higher priority to accomplish.

The initial organization of the interview and follow-on interviews dealt with questions that had definitive responses. For example, one question that began the interview was, "What document(s) initiates the formal study?" Avoidance of questions that probed opinions, conjecture and beliefs reduced obstacles to the interview's completion. From this

organized approach, it became possible to piece together in data flow diagrams the process that each study team followed in the development of its Threat Force File.

While obtaining the initial workings of the file's development was important, it was also critical to verify the accuracy of the diagrams with the users. This activity required repetitive application as it was necessary to insure the physical data flow diagrams accurately portrayed the system as the users perceived it. Appendices A through D were the diagrams generated from this phase of the analysis effort.

Objectives and Priorities Definition. This phase of the methodology served as a transition point from describing the existing system to postulating possible solutions for the proposed system (those which attempt to correct the problems). The goal of this phase was to abstract the physical representation of each study team's Threat Force File development process into an all encompassing logical description of the system. By abstracting and aggregating (Ref 12), it was possible to focus attention on the system's logical requirements rather than becoming immersed in the physical aspects under study. The resulting logical data flow diagram had two benefits: 1) it minimized the requirement for technical expertise to understand what was being portrayed and 2) it allowed for the development of proposed alterations, additions or deletions to the systems requirements.

With regard to the Threat Force File development process, the individual study team's physical diagrams were consolidated

and abstracted to represent the existing logical situation across all four teams. This activity resulted in the logical data flow diagram found in Appendix E. This diagram, as with the others, was reviewed with the users for accuracy and possible corrections. This document became the starting point from which changes to the system could be addressed.

The proposed logical data flow diagram (Appendix F), expresses the consolidation of the data collection activity and data sources through one centralized process. This would allow for control and management of the information and also reduce the problems of data redundancy and inconsistency due to duplicated collection. Lastly, the hours expended in the mechanical retrieval of data may be greatly reduced as the needed data is collected only once. Solutions that were presented as possible alternatives for this process were: 1) the centralization of the data collection activity with the Data Systems Team, 2) incorporation of a threat-unit database under the control of the Data Systems Team, 3) automation/control of the preparation and input to the Armed Forces Planning Document and Assumptions (AFPDA), 4) development and standardization of system utilities for use by the file developers, and 5) centralized authority over computer resource management. It was understood that these recommendations were made based upon analysis of the existing Threat Force File development process and the desire to alleviate well articulated problems. The final decision for implementation rests within USACAA and must be weighted against other competing interests.

As stated earlier, the remaining phases of Weinberg's methodology were not addressed as the initial three served to satisfy the requested evaluation. If the analysis activity were to continue, preparation of a data dictionary would begin at this junction. Creation of the data dictionary for the entire model is under progress as of the time of this work. Should a desire to continue the analysis exist, the completion of the data dictionary and inclusion of this study effort will provide a resource for further refinement and revision of potential solutions.

III. Logical Database Design

> "Designing a database is a difficult, complex, and unstructured process. The resulting logical database structure becomes inadequate when it is unable to satisfy the present and future requirements of the organization and its community of users" (Ref 10:1).

Concepts

A database management system (DBMS) can be an effective tool for the management of data. It can render assistance in dealing with an organization's informational problems and improve the decision making capability by providing timely and accurate information. Conversely, a DBMS can be an expensive, inflexible, and cumbersome addition of data processing capability which successful organizations can ill afford. The category into which a DBMS falls is normally determined by the design of the logical database (Ref 14:147).

A database is a total collection of stored operational data (Ref 4:4, 16:1). The logical database is incorporated into this definition by providing an abstract representation of the community user's view of the stored data. This view is not constrained by the way in which the data is physically ordered on the storage medium.

Design of a logical database is not a simplistic process. In order to provide valuable design products, it is necessary to observe the guidelines of a pragmatic design strategy. A structured approach maintains the focus of the design effort on those areas which demand critical attention so as to avoid development of an unresponsive and ineffective database.

There are numerous logical database design strategies available for use in guiding the design effort (Ref 1,2,5,6, 7,10,11,12,13,14,15). While each strategy has its own unique characteristics and intricacies, the majority fit well into four broad areas of design activity. These areas are: 1) collection/analysis of data, 2) determination of the questions, decisions and informational needs the data must support (data processing requirements), 3) the actual development of the logical schema design, and 4) description of the data-model specific logical schema.

The remainder of this chapter will concentrate on understanding these design activities and how they integrate to provide a viable logical database design. Additionally, the concluding portion of this chapter will be devoted to a review of current design methodologies.

Data Collection/Analysis. Data collection serves as the fundamental building block for logical database design. It is during this phase that potential users of the proposed database are surveyed for the information that will determine the composition of the logical database. Information to be collected consists of data that an organization records and uses on a routine basis. Additionally, data is collected on the informational needs that are not being met or are being met with difficulty by the existing informational management system (Ref 13:183).

Survey techniques which dominate the data collection process are the oral interview and the written questionaire.

These two forms of information gathering are widely recognized as the most effective methods for obtaining the desired data (Ref 2:139, 5:141, 7:24, 13:183, 14:147). The logical database design, being formulated from "user's views", relies upon the feedback and negotiation exchanged during this process to insure an accurate representation of the database specification.

The data analysis portion of the design activity consists of synthesizing the gathered information into recognizable structures that reflect an organization's understanding of its data. Several methodologies share common points in the conduct of this activity (Ref 2,5,6,7,10,11,13,14,15). The first area of commonality is the selection of entities. Entities are the concepts or objects of interest to an organization about which facts are kept or recorded (Ref 10;49, 4:8). Secondly, focusing on those recorded facts determines a particular set of attributes for each entity. A third area, which analysis activities share, is the identification of key attributes. This specific attribute is a unique item of information which is used to determine other attributes in the same entity. Figure 2 provides an example of these recognizable structures. Employee is the entity of interest. Name, Address and Social Security Number are the facts (attributes) and Social Security Number is the key attribute (unique) which is used to identify the entity facts (Fig. 3). The last area of common interest is the determination and definition of relationships between entities. This area

specifies the known correspondence (mapping property) that exists between separate entities (Ref 13:142). These mapping properties fall into three categories: 1 : 1 (one-to-one), 1 : N (one-to-many), and M : N (many-to-many).

The data collection/analysis process is a time consuming activity which requires a great deal of repetitive application between users and database designer. It is most important that the designer be meticulous in this portion of the design effort and continually validate the accuracy of the obtained data. Careful planning and effort invested in the initial phase of logical database design can build in flexibility at the earliest stage.

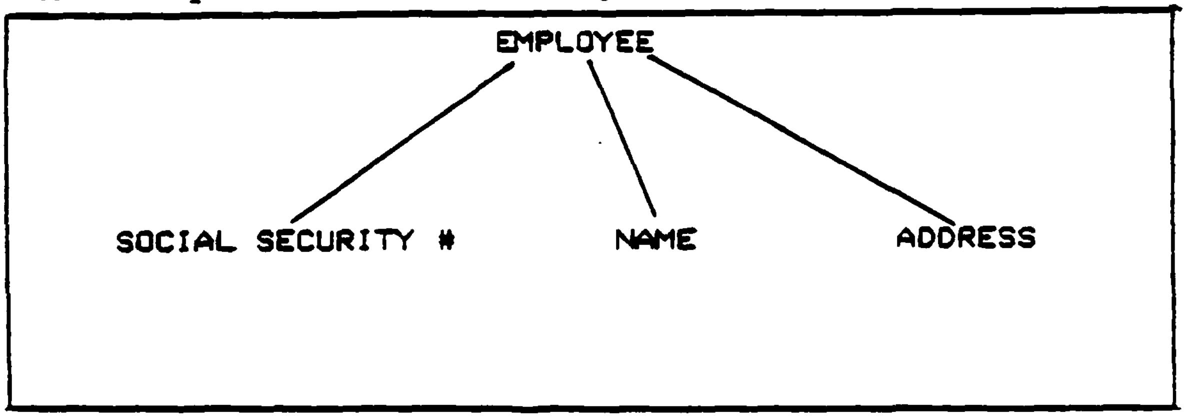

Figure 2. Entity and Attributes Example

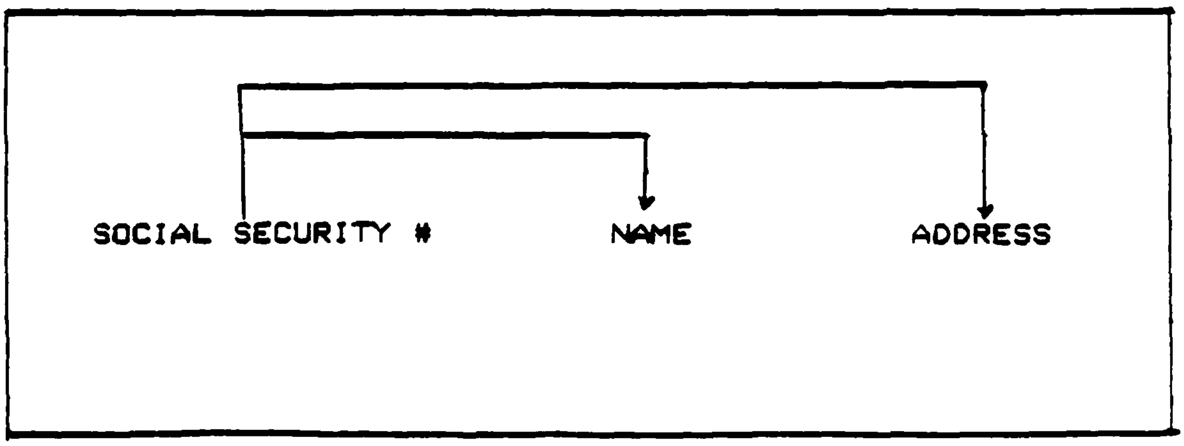

Figure 3. Key Attribute Example

Data Processing Requirements. This design activity concentrates on defining current and future data processing requirements that an organization demands of its data management system. The goal is to identify those questions, decisions, transactions, and applications that the designed logical database must be able to support in an efficient manner. The reason for obtaining future requirements is to introduce flexibility into the design and preclude radical alteration or restructuring of the database as an organization's information demands change.

Many logical database design strategies gather information on this aspect in much the same manner as expressed in data collection/analysis. Structured interviews and questionaires focus attention on specification of the processing requirements. This effort helps to involve the users in the design process and insure the resulting design is not obsolete prior to implementation.

Other areas which serve as sources for processing requirements are an organization's reports and memorandums. This information highlights those data requirements that an organization feels are significant. It is also quite possible during the collection of this information that new and never before discovered relationships among entities will be uncovered. This activity provides an additional feedback mechanism for the data collection/analysis process. These new, surfaced relationships can be included with the existing information to enhance the logical database flexibility.

Information garnered from determination of the data processing requirements can be consolidated with the data previously collected and analyzed. The resulting product provides the starting point for development of the logical schema.

Logical Schema Design. The logical schema is a definition of the proposed database at a high level of abstraction. The purpose of the abstracted definition is to avoid the details of specific (hierarchial, network, relational) data-models. This allows one to view the database's logical requirements and composition without becoming immersed in the implementation details.

Current design strategies recognize two principal components of this phase: first, modeling of individual user views of the data and secondly integration of individual views into a single global structure. Modeling of individual views concentrates on the representation of entities and relationships as perceived by individual parties involved in the organization. Many techniques are available for this work with the majority concentrating on a form of graphical representation (Ref 2,5,6,7,10,11,12,13,14,15).

The development of these individual views further refines the requirements of the logical database. The graphical diagrams generated from this effort must be verified with the user to insure that the captured representation is accurate. If there are inadequacies with the diagrams, this is the point at which alterations can and should be made.

Finding inconsistencies after physical implementation results in expensive and time consuming database restructuring.

Integration of the individual views into a single global structure provides a "generic" or abstract view of the entire logical database specification (community user's view). This is the logical schema which defines the structure and composition of the database and which attempts to fulfill the organization's information requirements. In the majority of methodologies, the individual views are incorporated, one at a time, until all have been integrated into a single structure. Normalization checks (Ref 11,12,13,14,15) are made to reduce redundancy and remove unwanted relationships and dependencies between the data entities. The resulting product is a draft logical schema design. As with the other intermediate products, review and verification must be undertaken to eliminate inaccuracies prior to commitment to a data-model specific logical schema description.

Data-Model Specific Logical Schema Description. This concluding phase of the design concepts introduce those data-model specific details of logical database design. While these details were purposely omitted from previous discussion, they now play an important role in translating the logical schema design into a data-model specific logical schema. The ability to specify the logical schema, without regard for its implementation requirements, was valuable for preparation of the theoretical portions of the design. In order to provide a more refined and useable product, however, the logical schema must be made accessible to commercially available

database management systems. These systems fall into three data-model categories: hierarchial, network and relational (Ref 4:63, 16:72). The objective of this last design phase is to transform the logical schema design into a schema design that conforms to the specifications of the chosen data-model. Selection of the data-model to be used in the design work may or may not be within the database designer's span of control. In most cases, the designer will have to address transformation of the design based upon the current data-model followed by the DBMS in use. An overview of this transformation process is discussed for each type of data-model.

A DBMS that is based upon the hierarchial data-model has its foundations in the form of a tree structure (Fig. 4). In this case, the children nodes can have only one parent, but a parent node may have multiple children. Access to the information is gained by following pre-defined paths from parent to child until the appropriate level, containing the desired information, is found.

Transformation of a logical schema into a hierarchial data-model lies in the ability of the designer to specify the logical schema's relationships into parent-child relationships. Entities involved become parents or children depending upon how the relationship is portrayed. Entity information, that is frequently required, can be located towards the top of the hierarchy allowing for faster retrieval.

A commercial DBMS founded on the principles of the network data-model can also be viewed in the parent-child context (Fig. 6). In this model, however, a child node may have

multiple parents. Access to information follows pre-defined paths as was the case for the hierarchial data-model. The network data-model though, allows for multiple paths to the same child. It is not necessary to follow the same path every time.

Transformation of a logical schema into a network data-model description is a more much difficult task than the hierarchial structure. Entities are owners and members with relationships being portrayed as sets between the two. In some instances, a connector record must be used to maintain the functionality of the relationship (Ref 14:150, 15:126). This data-model is more flexible in terms of information access than the hierarchial model, but there is an associated increase in complexity accompanying implementation.

A relational DBMS uses tables as its cornerstone for information manipulation (Fig 5.). There are no pre-defined access paths to follow for the data retrieval, as was the case for the network and hierarchial data-models. Useable information is obtained through various table operations and the combining (joining) of tables to specify certain relationships.

Transformation of a logical schema into a relational data-model lies in the specification of the entities and associated attributes into base tables (tables that are permanently stored in the database). Relationships between entities are defined through the combination of proper base tables. While this data-model is the most flexible of the

three models discussed, its current commercial availability is limited. Research is still underway to discover the ramifications associated with the model's use.

This completes discussion of the functional aspects required for logical database design. Attention can now be focused on the review of certain design methodologies and how they address these principal design activities.

Methodology Review

Having completed an analysis of the pertinent areas involved in the design of a logical database, attention can be directed towards specific strategies that attempt to focus the design activity. Three pragmatic approaches have been identified for discussion. These strategies are proposed by: 1) Teorey and Fry (Ref 13), 2) Holland (Ref 5), and 3) Tsichritzis and Lochovsky (Ref 14,15). The criteria for selecting these methodologies was based upon the need to design a real-time database to support model analysis activity conducted at USACAA. These strategies took an applications approach to design rather than the academic or theoretical approach found in most of the research literature.

The remainder of this chapter discusses how each methodology appears to perform in the functional design areas. It is from this review that justification for selection and use of all, or part of a design approach, is based. These selections will be applied to the development of logical database designs for the CEM V output (Chapter 4).

Teorey and Fry Methodology. The database design methodology presented by Teorey and Fry provides a step-by-step approach to the development of a data-model specific logical database. While this strategy covers the entire spectrum of database design, the authors devote the majority of their work to a discussion of the logical schema design concepts. The methodology consists of three principal phases: 1) requirements formulation and analysis, 2) logical design, and 3) physical design. These majcr phases favorably correspond to the general logical database design concepts and can be reviewed accordingly.

Teorey and Fry accomplish the data collection/analysis and data processing requirements under their requirements formulation and analysis phase. They recommend the use of personal interviews with various levels of management and key personnel as the means of obtaining an understanding of the informational requirements of the organization. The data processing requirements are gathered from the same interview techniques. The methodology also stresses the use of a data requirements language as a vehicle for documenting the information gained during these phases. Identification of data elements and relationships is postponed until the logical design phase.

During the logical design phase, Teorey and Fry present more refined guidelines for the preparation of the logical schema design. It is during this phase that entities, attributes and relationships are identified to satisfy the

users' needs. The authors recognize the need to incorporate those data elements into individual models and to integrate those models into a single global structure. The strategy emphasizes maximum use of graphical diagrams and encourages user verification of intermediate design products. This aspect of the design methodology is extremely detailed and provides the core of Teorey and Fry's work.

To conclude the logical design portion of their pragmatic strategy, Teorey and Fry address the transformation of the logical schema into a data-model specific logical schema. The authors do not attempt to provide any details regarding the transformation process but merely to draw attention to the completion of this activity prior to moving into the physical design phase.

Taken in total, this methodology does a credible job at presenting a complete strategy for logical database design. The phase of logical design was extremely detailed and precise. Its applications approach left little to chance in the preparation of the logical schema design. The other design concepts were treated well, but none approached the depth accorded to logical schema design.

A feature of interest, covered by Teorey and Fry's methodology, dealt with the determination of the transport volume associated with a logical schema design. This tool provides insight into the amount of information (bytes) expected to be retrieved under control of a specific database application or transaction. This feature has potential

application for systems analysis activity and can lead to refinement of the logical schema for more efficient data processing.

In summary, this methodology has good techniques for development of the logical schema design. Additionally, the calculation of transport volume is a valuable mechanism for estimating the efficiency of a logical database design.

Holland Methodology. The Holland design strategy is limited to the specification of the individual user's views (one component of logical schema design), rather than treatment of the entire design process. Holland presents a series of rules for developing the intermediate products of this design activity.

While Holland does not address the data collection/ analysis concept formally, he does recommend that certain information sources be reviewed for determination of the user views. These areas are: personal interviews of an organization's key personnel, review of special demand and routine reports, informational requirements expressed by preformatted CRT screens, and potential on-line data demands.

Based upon the information gained from these recommended sources, Holland concentrates his strategy on the accurate representation of the data as viewed by the individual users. The rules he postulates deal with the functional dependencies of attributes and the selection of appropriate keys to satisfy those dependencies. Holland does not attempt to integrate the individual views into one structure, nor does

he address normalization checks. Data-model descriptions are also omitted from the strategy.

This approach is oriented towards a specific utility for use in logical database design rather than a stepwise methodology. The rules Holland presents are clear and instructional. This approach is directed towards real-world application and less on the details of theoretical concepts. The limited scope of the author's work is a good view of one aspect of the logical schema design concept.

Tsichritzis and Lochovsky Methodology. Similar to the design strategy of Teorey and Fry, these authors provide a stepwise approach that closely parallels those recognized concepts of logical database design. Unlike Teorey and Fry, however, an attempt is made to discuss all the design concepts in the same amount of detail. The methodology presented by Tsichritzis and Lochovsky is composed of three steps: 1) requirements analysis, 2) enterprise description, and 3) database description. The objective of Tsichritzis and Lochovsky's methodology is the specification of a data-model specific logical schema that satisfies the user's informational requirements.

The information found in the data collection/analysis design concept is obtained through the first two steps of this methodology. Requirements analysis focuses on gaining an understanding of the organization and its goals. Information collected during this activity concentrates on the data and processes used by the organization. In addition,

interviews are conducted and documents studied to further define and clarify the organization's informational requirements.

The second step, enterprise description, takes the information gained from the requirements analysis and determines the entities, attributes and relationships that will be involved in the logical schema specification. Tsichritzis and Lochovsky recommend the use of the entity-relationship diagram (Ref 3) for graphically portraying the information under study. These diagrams provide the individual views of the data.

Tsichritzis and Lochovsky take their developed diagrams and construct a single abstract structure that is representative of the global data perspective. Preparation of the global view is accomplished through the systematic integration of each individual view. At this point the logical schema has been specified and is known as the enterprise description. As a concluding step, Tsichritzis and Lochovsky discuss the organizations specific data processing requirements. The objective is to obtain all the current and proposed transactions, applications or on-line queries that will be levied against a database. The logical schema is reviewed against those requirements and alterations are made as necessary.

The third step of Tsichritzis and Lochovsky's strategy takes the logical schema (enterprise description) and translates it into a data-model specific logical schema (database description). The goal is to conform the logical

schema design to the requirements of the data-model used by the targeted DBMS. The transformation process for each type of data-model (hierarchial, network and relational) is discussed in general terms.

The methodology presented by Tsichritzis and Lochovsky is most complete in its treatment of the concepts of logical database design. Each activity is discussed with equal regard and importance. Overall, the methodology provides a sound approach to the development of a logical database. The strategy is clear, easy to follow, and takes an applications approach to solving design problems. Incorporation of better defined design techniques may further enhance the strategy, but the framework is more than sufficient to direct the design effort.

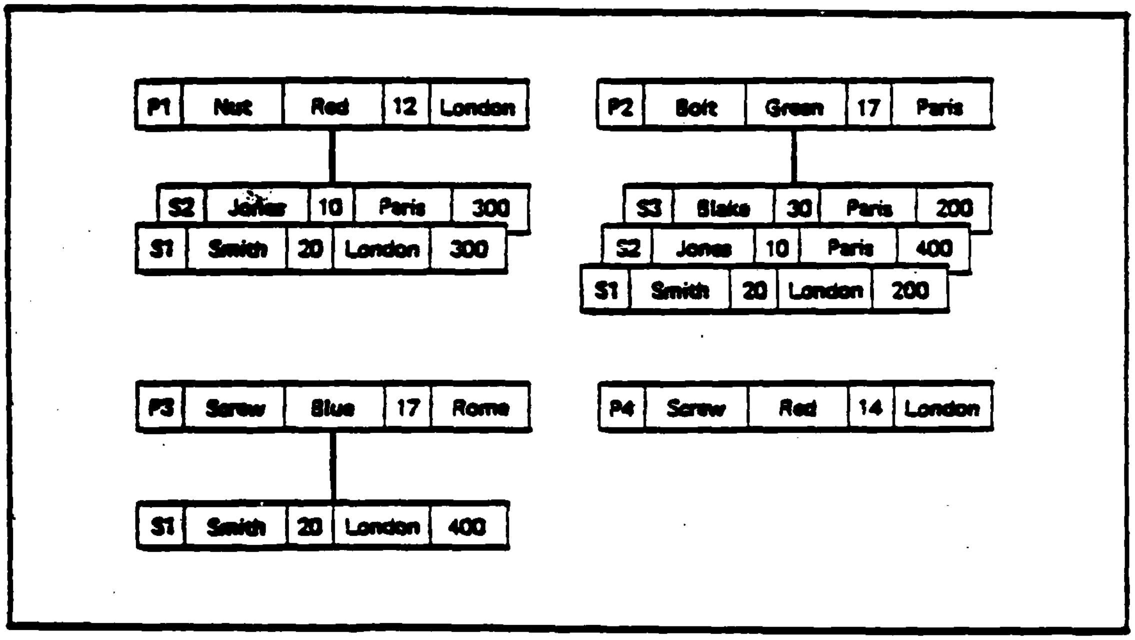

Figure 4. Hierarchial Data-Model (Ref 4:68)

S

S#	SNAME	STATUS	CITY
S1	Smith	20	London
S2	Jones	10	Paris
S3	Blake	30	Paris
S4	Clark	20	London
S5	Adams	30	Athens

P

P#	PNAME	COLOR	WEIGHT	CITY
P1	Nut	Red	12	London
P2	Bolt	Green	17	Paris
P3	Screw	Blue	17	Rome
P4	Screw	Red	14	London
P5	Cam	Blue	12	Paris
P6	Cog	Red	19	London

SP

S#	P#	QTY
S1	P1	300
S1	P2	200
S1	P3	400
S1	P4	200
S1	P5	100
S1	P6	100
S2	P1	300
S2	P2	400
S3	P2	200
S4	P2	200
S4	P4	300
S4	P5	400

Figure 5. Relational Data-Model (Ref 4:64)

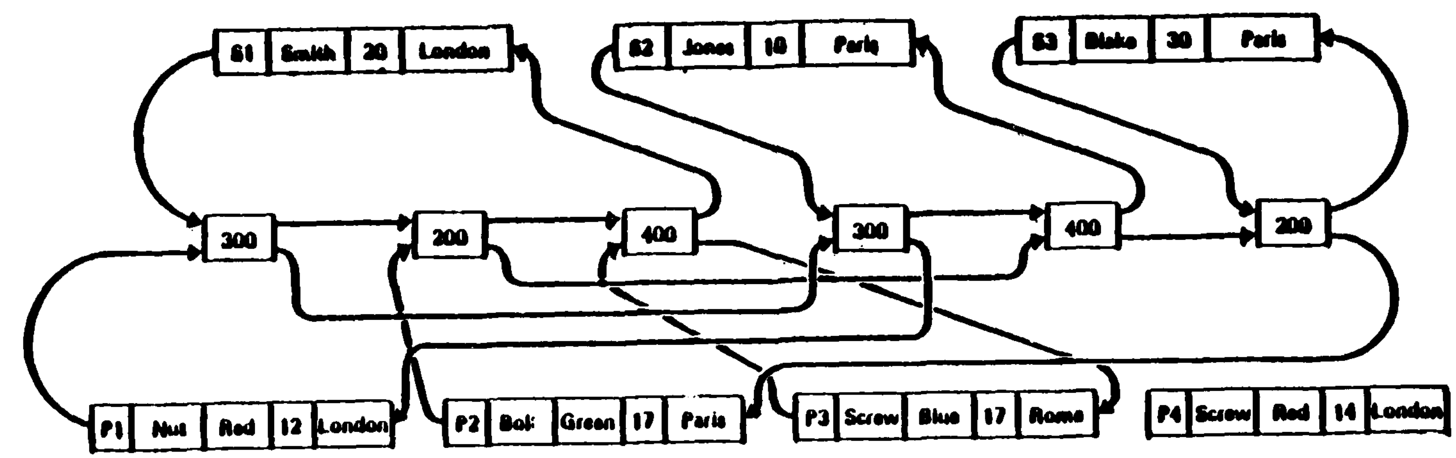

Figure 6. Network Data-Model (Ref 4:71)

IV. Logical Database Design Application - CEM V

Introduction

The Concepts Evaluation Model (CEM V), used by USACAA as its primary simulation tool, generates a substantial amount of data output each time the model is run. The output is checked to be certain that the model is producing an intuitively correct response for the given input information. This process may be repeated several times. When the study team is satisfied that the model is "calibrated", a baseline case is established. Model runs generated in response to changes in the input information are called "excursions". Multiple excursions may be required to fulfill one study. It is the output produced from these excursions which the analysts must use in their presentations and briefings. As these studies relate to problems deemed significant by the Army Staff, the need for accurate and responsive retrieval of information is paramount to the success of each study team. Currently, the study analysts must sift through thousands of pages of model printouts to obtain the detailed information that is requested in these study briefings. It is this need for precise information that sparked interest in the application of database technology to the output produced by the CEM V.

The scope of this portion of the thesis will be limited to the design of logical subject databases to support a more efficient and responsive use of the CEM V output. The use of selected design techniques, in accordance with the concepts

of logical database design, provided the necessary focus for the development of the desired model databases.

Data Collection/Analysis

Prior to any design work it was necessary to understand the informational desires and requirements that the specific designs had to satisfy. The adequacy of the designs is predicated upon the information gained from this understanding. This is why the concept of data collection/analysis is so important to the successful development of any logical database design. While time consuming and frustrating, the knowledge achieved from this activity can measureably increase the flexibility of the database and improve the information management effectiveness.

In the case of the Concepts Evaluation Model (CEM V) output, structured interviews were conducted with various members of the individual study teams. This tool, structured interviews, was chosen as it allowed for an encouraged maximum interaction between the designer and the study analysts. While this technique is not specific to any one design methodology, it is readily recognized by the majority as a useful means of gathering information (Ref 2,5,7,13,14,15).

Specific questions addressed during the interviews attempted to concentrate attention on the information that each study team needed (or desired) for completion of a study requirement. The questions that were asked included:

1. What are the objects (entities) of CEM V output that are of interest to the study team?

2. What is the appropriate name for each entity?

3. What are the facts (attributes) of interest for each entity?

4. What are the appropriate names for each attribute?

5. What is the domain of values for each entity?

6. What are the known dependencies (relationships) between entities and attributes?

7. What are the unique identifiers (keys) for each entity?

These questions were taken directly from the Tsichritzis and Lochovsky methodology (Ref 14:147). The reason for selecting these questions was due to the detail in which the data collection/analysis process was covered by these authors. It was the only methodology that addressed the specifics of this design concept. The other strategies mentioned the need for the activity but did not present specific recommendations for approaching the task.

An additional area that was explored for information was the reports produced by the CEM V's post processors. Holland, in his methodology (Ref 5:141), suggested a review of these documents as a further aid to understanding the informational needs of the organization. The reports that were analyzed from the CEM V output were: theater summary, casualty report, logistics summary, item-specific logistics report, tactical air summary, unit status, and a forward edge of the battle area (FEBA) trace report. The data gained from these reports served to confirm the information uncovered during respective interviews. Additionally, it helped in the further identification of relationships between data objects.

Appendix G provides a list of entities and attributes for the CEM V output. Appendix H lists the relationships found to exist among the entities and their associated mapping properties.

Data Processing Requirements

The second concept to be applied to the design of logical databases for the CEM V was the determination of the data processing requirements for the individual study teams. The objective was to identify and document questions, transactions, decisions, and applications that would require information contained in the designed, logical databases. This effort was aimed at capturing the current needs as well as the projected requirements anticipated by the respective study teams.

Structured interviews were used as the principal means for collecting the desired information. As before, this tool was selected because it facilitated communication of information between the parties involved. Additionally, this approach emphasized user verification of the information while it was still fresh in everyone's mind. Questions for this portion of the design were again extracted from the Tsichritzis and Lochovsky methodology. These questions served as a fundamental starting point and were applicable to the goal of the design activity. The other methodologies, as was the case in data collection/analysis, failed to adequately address the aspects of this design concept.

Questions that were included in each of the interviews were:

1. What are the transactions, questions, decisions that the study teams need to answer from the CEM V output?

2. What kind of access (retrieval, update) is required by each transaction?

3. Which entities, attributes, relationships are involved in each transaction?

Appendix I identifies those questions which the individual study teams found important to their analysis activity.

Logical Schema Design

Design of the logical schema is the first step in actually specifying the structure of the proposed database. This concept of logical database design concentrated on the accurate modeling of the information gained in the data collection/analysis and processing requirements determination phases. The two components which comprise this activity were: 1) the specification of individual user views, and 2) incorporation of the individual views into a single global structure. The result of this activity was a representation of the logical schema which included the entities and functional relationships necessary to satisfy the informational requirements of the organization.

The approach selected for application of this concept to the CEM V output was provided by the methodology of Teorey and Fry. These authors devoted a majority of their strategy to this phase. While maintaining the theoretical correctness of their work, Teorey and Fry made a great effort to insure

the viability of its real-world application.

The authors recommended the use of the entity-relationship diagram (Ref 3) as did Tsichritzis and Lochovsky for modeling the various views of the data. This technique was chosen to describe the various data views of the CEM V output because of the technique's similarity to the structure of network data-models. Knowing that the DMS-1100, used by USACAA, was based upon a network data-model, it seemed a matter of convenience to use a descriptive tool that would simplify the future transformation of the logical schema into a data-model specific logical schema. This idea may seem contradictory, but the use of entity-relationship diagrams is totally consistent with the goal of preparing a data-model independent logical schema. These diagrams, while facilitating transformation to a network structure, could be used to transform a logical schema into a relational or hierarchial data-model. The entity-relationship diagram provided a convenient way to describe the logical schema with a view towards the final design activity.

The first aspect of Teorey and Fry's approach to logical schema design was to identify the individual views and model them according to the entity-relationship diagram. In the case of the CEM V output, each of the four study teams was questioned as to how it saw the relationships between entities and attributes. Not surprisingly, the individual views provided by each study team, were consistent with one another in the way the data was viewed. This observation was due to

the precise structure of the CEM V output and the overlapping study requirements between teams. In several cases, however, one team had a view of the data that another team had not even considered. As these veiws were obtained and modeled, they were reviewed and verified with the study teams to insure an accurate representation. The resulting entity-relationship diagrams are provided in Appendix J.

Once the individual views were obtained and consolidated, it was possible to move into the second component of the design phase, integration of the individual views into a single global structure. It was during this time that normalization checks were made to reduce redundancy, insure functional dependence and remove transitive dependencies.

Integrating the individual views of the CEM V output produced a complex global structure. Appendix K demonstrates the structure resulting from this process. At this junction the real-world constraints became important to the design. Members of the Data System Team, upon seeing the complexity of the logical schema, proposed the use of the individual team views as subject databases. The idea, in this situation, was to specify a separate logical schema for each individual view. The trade-offs associated with this approach came in the form of increased redundancy for a more simplified design. USACAA was willing to trade memory useage for logical schemas that could be used by the untrained study analysts with a minimum of database familiarity. Additionally, the Data

Systems Team felt that it was beyond "in-house" capability to develop a coded conceptual schema and loader routine to implement the more complex design. Ultimately, it was decided to accept the imposition of redundancy into the design and to use multiple, simple logical database designs to satisfy the informational demands of the study teams. As a result, each of the individual views in Appendix J became a logical schema specification.

Data-Model Specific Logical Schema Design

Transforming the logical schema designs into a form that is responsive to a data-model specific DBMS is the goal of this last design concept. Completion of this activity provided the documentation necessary for the database administrator to generate the conceptual schemas (programming language specific database definition).

None of the methodologies reviewed provided the indepth details needed to accomplish this phase of the design effort. Tsichritzis and Lochovsky, however, did present a more specified approach regarding the transformation process than did the others. The authors focused on a high level perspective of mapping the entities into records (hierarchial and network) and base tables (relational). Additionally, they discussed the representation of entity relationships into DBTG sets (network) and table joins (relational).

Appendix L provides the data-model specific logical schema specifications targeted for use on the network oriented DMS-1100 database management system. The entities are

expressed as records and the relationships as sets between the records. Certain records are structured to insure the functionality of several relationships. These records, known as "connector records" in the network structure, are inserted as a result of the structure's inability to represent many-to-many (M : N) relationships. The record and set specifications for the subject databases of the CEM V output are presented in Appendix M.

Logical Schema Analysis

Conclusion of the logical database design effort does not end with the specification of the data-model specific logical schema. Analysis and testing of the logical schema should be undertaken prior to commitment to physical implementation or generation of a coded conceptual schema. Computation of the transport volume and estimated database storage requirements serve as two measures for the "fine tuning" of the logical design.

Appendix N provides an estimation as to the size of the CEM V subject databases. Appendix O gives example computations of the transport volume (as described by Teorey and Fry) for the logical schemas and the data processing requirements of USACAA's four study teams.

V. Recommendations and Conclusions

Conclusions

The purpose of this thesis investigation focused on two aspects of the data processing activity at the United States Army Concepts Analysis Agency. The first area studied concentrated on a systems analysis of the processes used in the development and preparation of the Threat Force File by the four major study teams at USACAA. The second area was concerned with the design of logical databases to support the information retrieval requirements associated with the Agency's use of the Concepts Evaluation Model (CEM V).

The systems analysis performed on the Threat Force File graphically portrayed the activities and interactions which took place during the prepartaion of this file for use with the CEM V. The documentation obtained from this analysis aided in the identification of those areas of overlap, redundancy and commonality that existed among the four study teams. The principal result was verification of the impact that the individual data collection processes had on the development of the file. It can be concluded that a restructuring of this one process (data collection) could achieve improved system performance and effectiveness by minimizing redundancy and eliminating excessive duplication of effort. Additionally, restructuring this process would enhance the integrity of the data by controlling the collection and distribution of information through documentation of the data sources.

Turning to the second area of this thesis investigation, a series of logical subject databases were designed for use with the output generated from the CEM V. The resulting data-model specific schemas were derived from a generic, logical database design approach discussed in chapter three. This strategy was achieved through research of existing design strategies and abstracted into concepts which categorized the required design activities. Specific techniques, used to realize the design concepts, were selected from applications oriented methodologies. These strategies aided in relating the theoretical aspects of logical database design to the real-world requirements of information management. The designs that resulted are a compromise between the theoretical "what should be" and the actual "what can be". An all inclusive database did not serve the purposes of USACAA at this point; however, these designs took an initial step to 1) provide intermediate products (logical database designs) which can be implemented by USACAA, and 2) documentation that serves as an initial foundation for a single database when (and if) the agency decides to embrace the idea.

Though the effort directed towards achieving a series of logical databases was realized, the resulting analysis surfaced a major area of concern regarding the storage requirements of these designs. The estimated size of a majority of the database designs, without taking into account the space that will be devoted to pointers, is immense. So much so that it appears the capacity of the DBMS and available

memory may be taxed beyond limits. In this case, even though a structured approach was followed meticulously, the importance of analysis becomes evident. Commitment to physical implementation, while possible, should be held in abeyance until further study clarifies the exact nature of the storage requirements.

Lastly, using information and observations gained from file preparation analysis, development of a single database and appropriate applications programs can eliminate the need for complete input file regeneration. An update, under database control, of only those data elements where a change is necessitated would reduce the time spent in manual input and aid in the development of an automated model-ready file.

Recommendations

The systems analysis undertaken with regard to the Threat Force File should be applied to all individual files which constitute the CEM V input deck. This would provide indepth documentation on all the processes and activities which go into a model-ready file. This information would benefit the developers of the next generation of CEM V by defining the manner in which the study teams go about their business. Further efforts in documenting the system would provide the management of USACAA with a mechanism for basing decisions on which administrative techniques could be used to improve system effectiveness.

Analysis of the designed logical databases needs to continue, especially where physical storage requirements are

concerned. Though it was not within the scope of this thesis investigation to address those physical aspects of design implementation, it is clear that further effort is necessary to reduce these massive databases. Follow-on study is recommended to review, and perhaps redefine, the informational needs of USACAA's study teams based upon this work.

It is also recommended that additional research effort be directed towards the development of a single database through the incorporation of this work and future efforts. This would encourage increased involvement of students with USACAA and provide research products that would be valuable to the Agency's personnel. It appears that budgetary constraints, normally associated with contract research, could be lessened with a continued infusion of thesis related topics into the Air Force Institute of Technology (AFIT).

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Appendix A

Physical DFD's - OMNIBUS Study Team

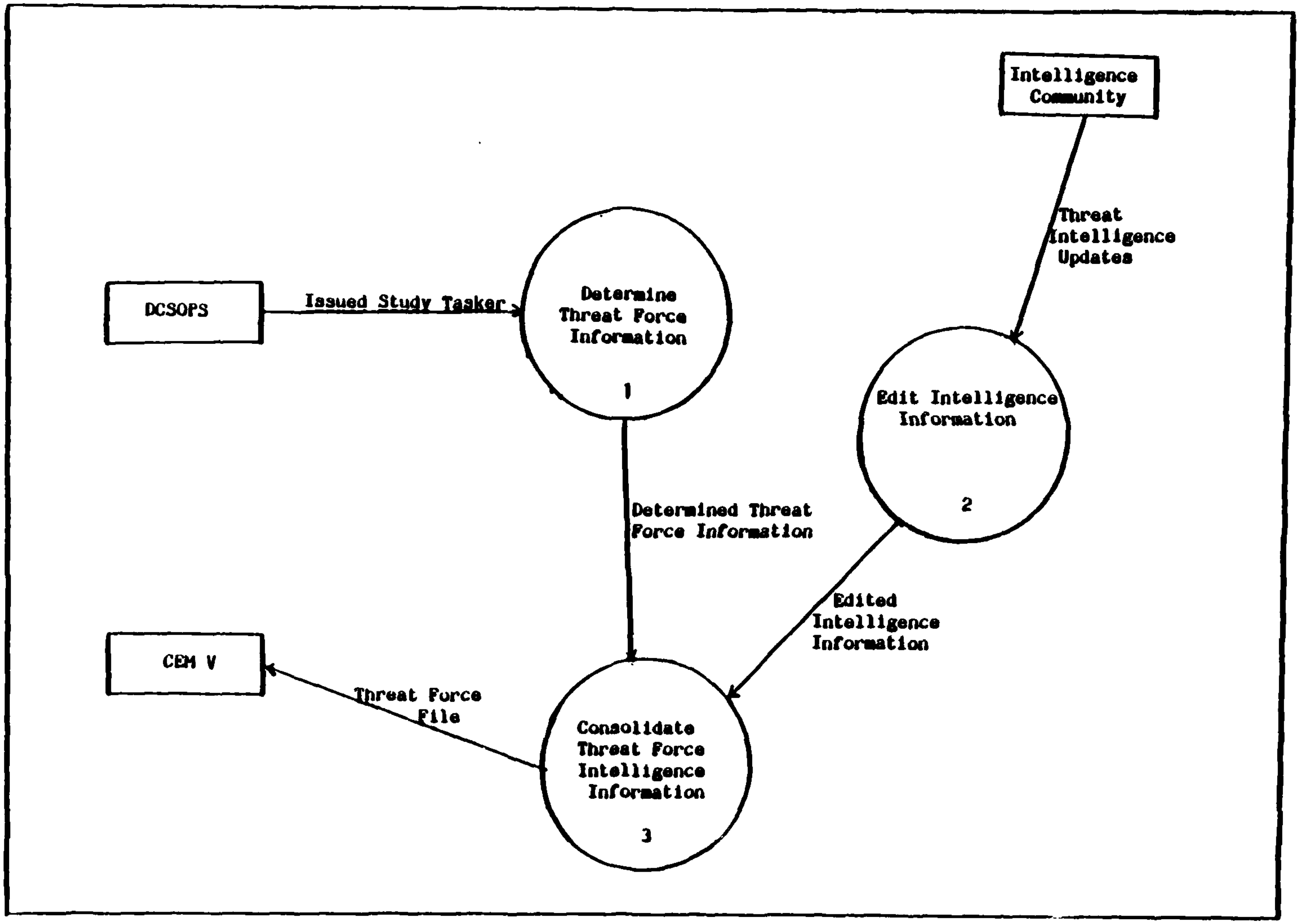


Figure A-1. Physical Overview DFD - OMNIBUS Study Team

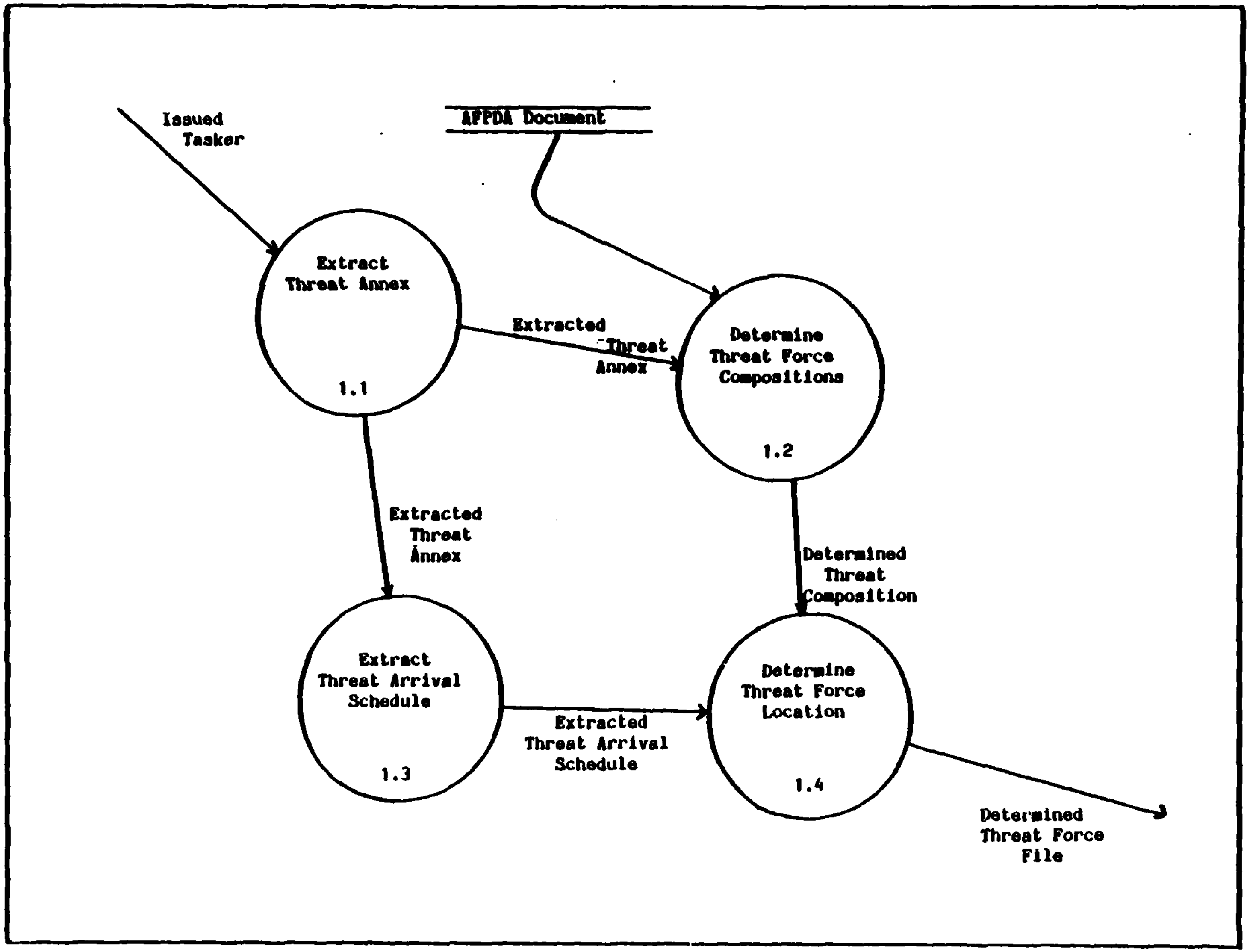


Figure A-2. Process 1, Physical DFD - OMNIBUS Study Team

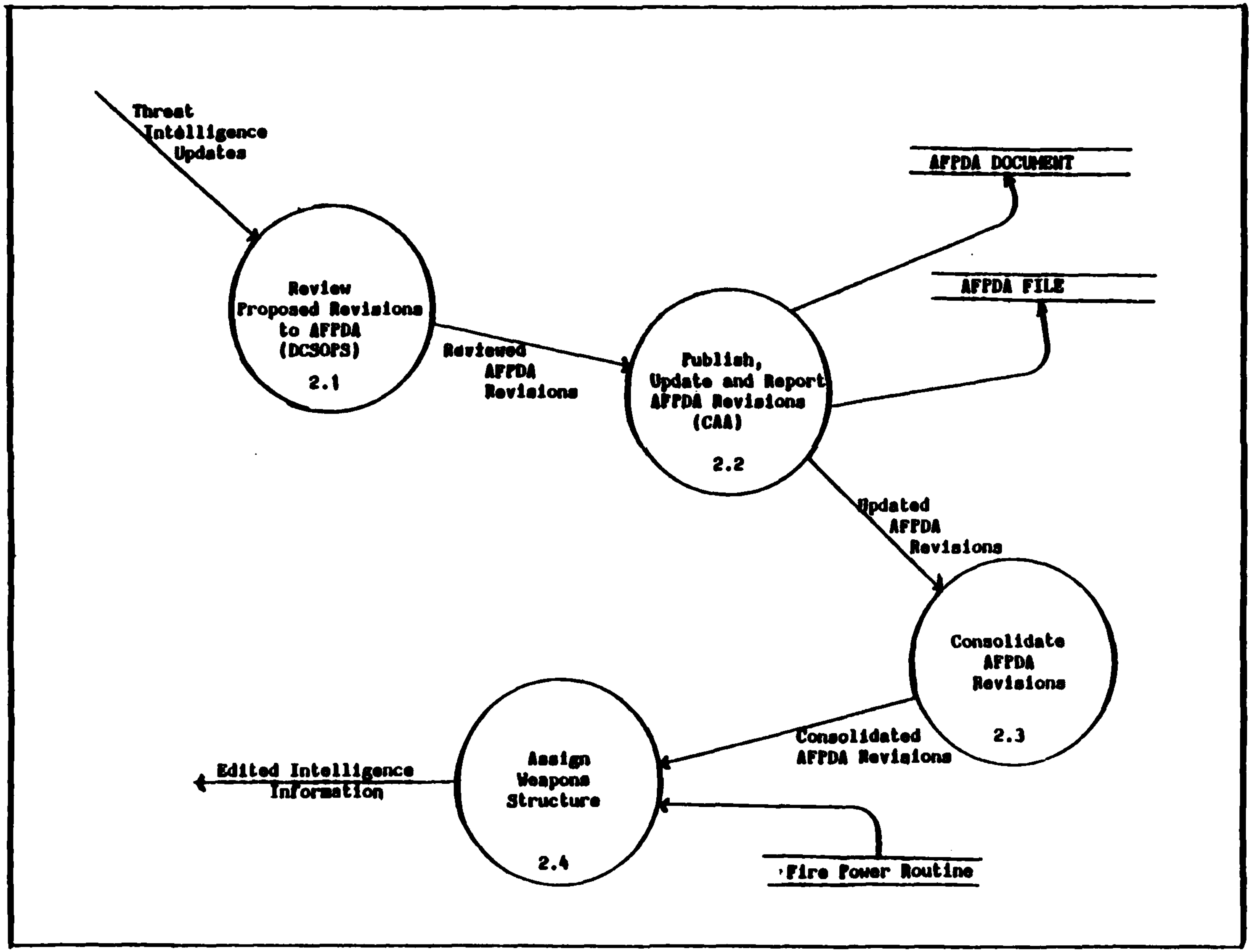


Figure A-3. Process 2, Physical DFD - OMNIBUS Study Team

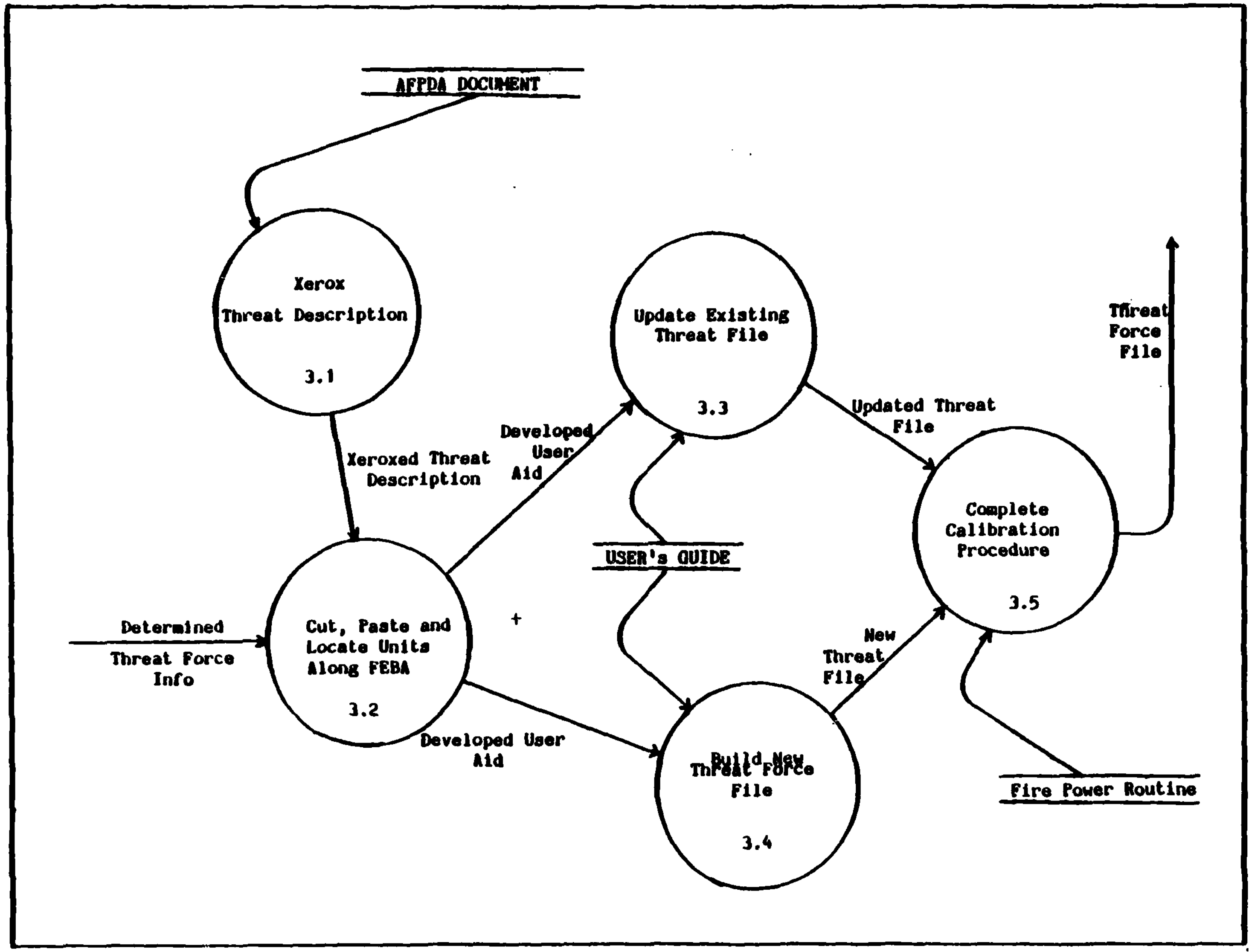


Figure A-4. Process 3, Physical DFD- OMNIBUS Study Team

Appendix B

Physical DFD's - TAA Study Team

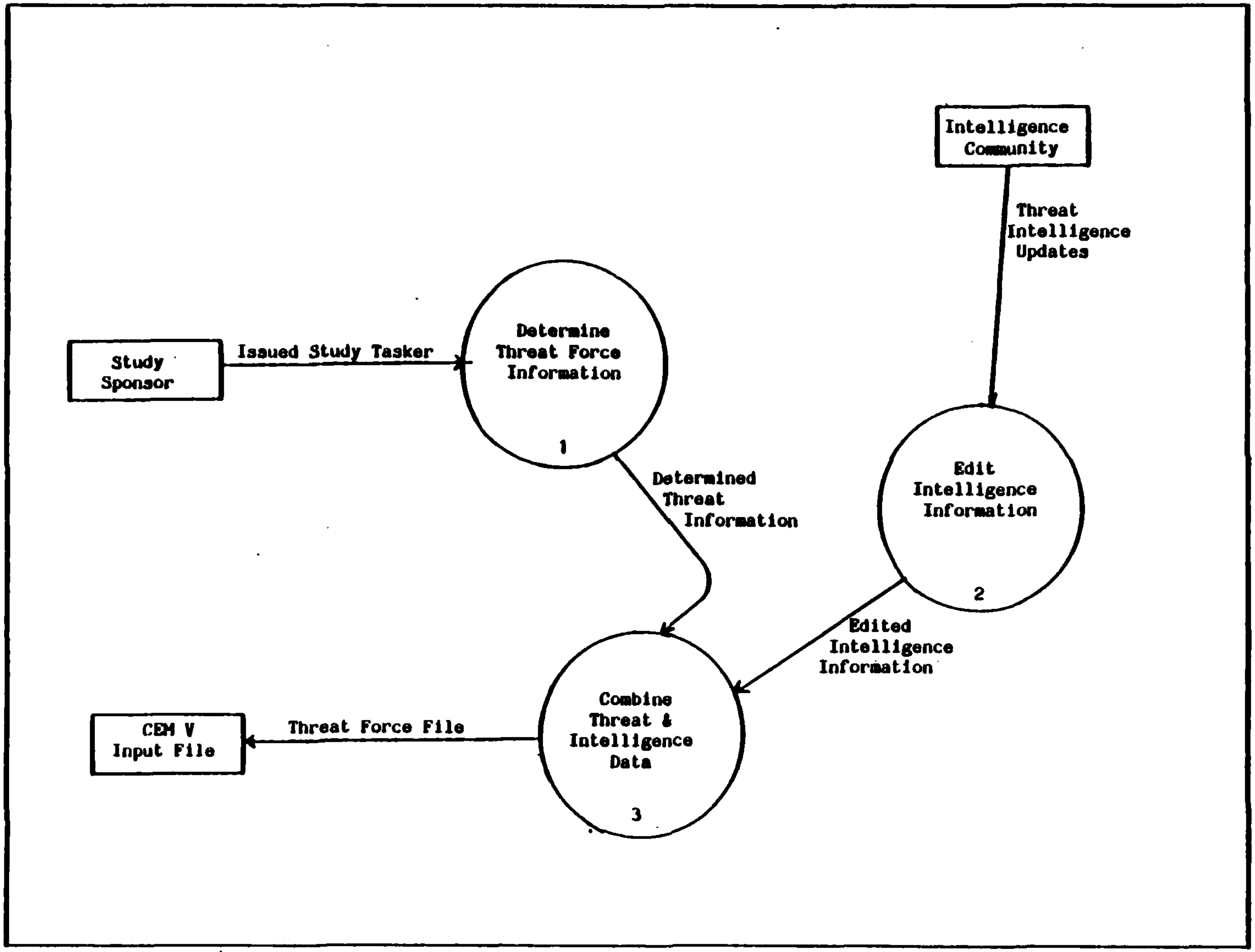
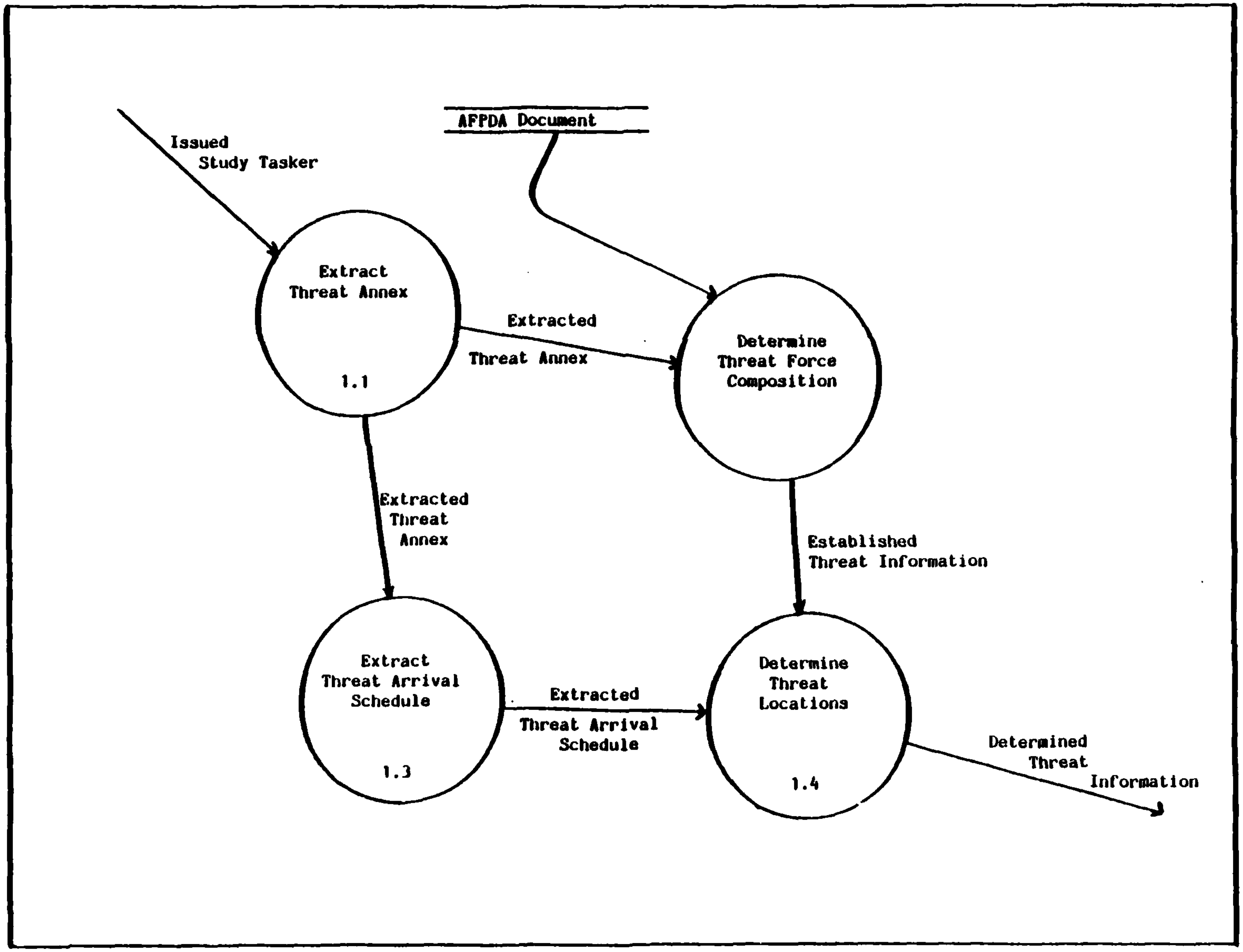


Figure B-1. Physical Overview DFD - TAA Study Team



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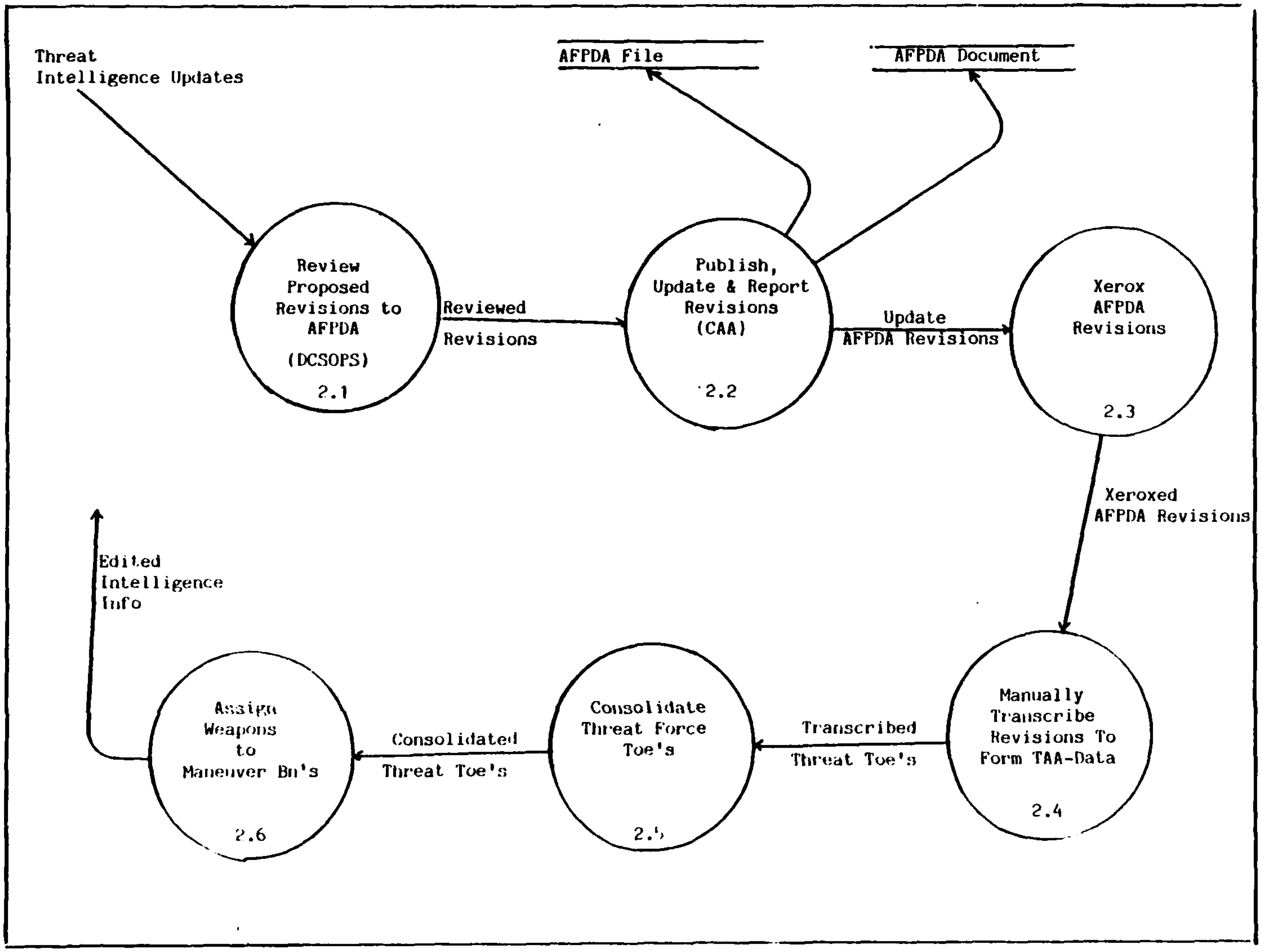

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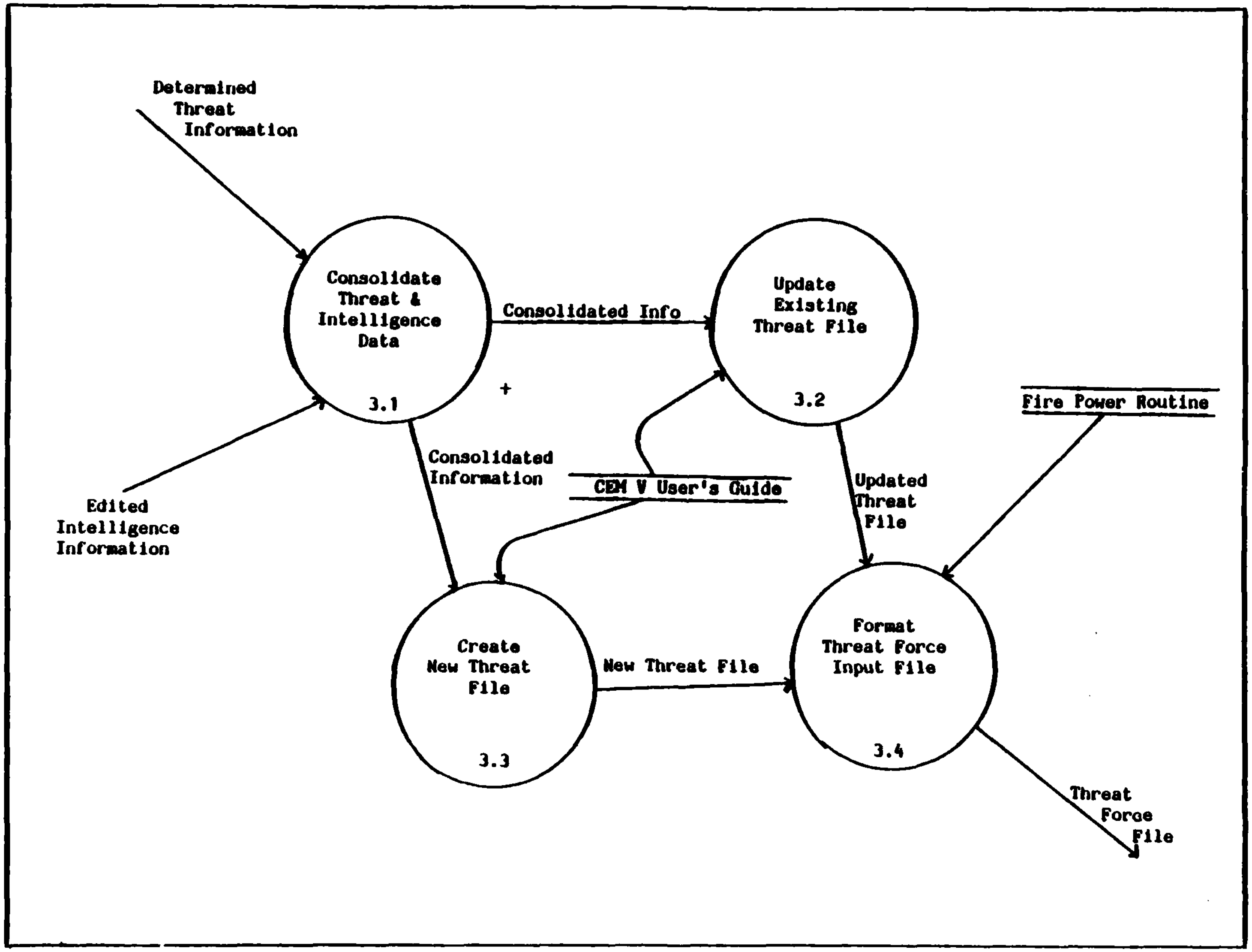


Figure B-4. Process 3, Physical DFD - TAA Study Team

Appendix C

Physical DFD's - RQ Study Team

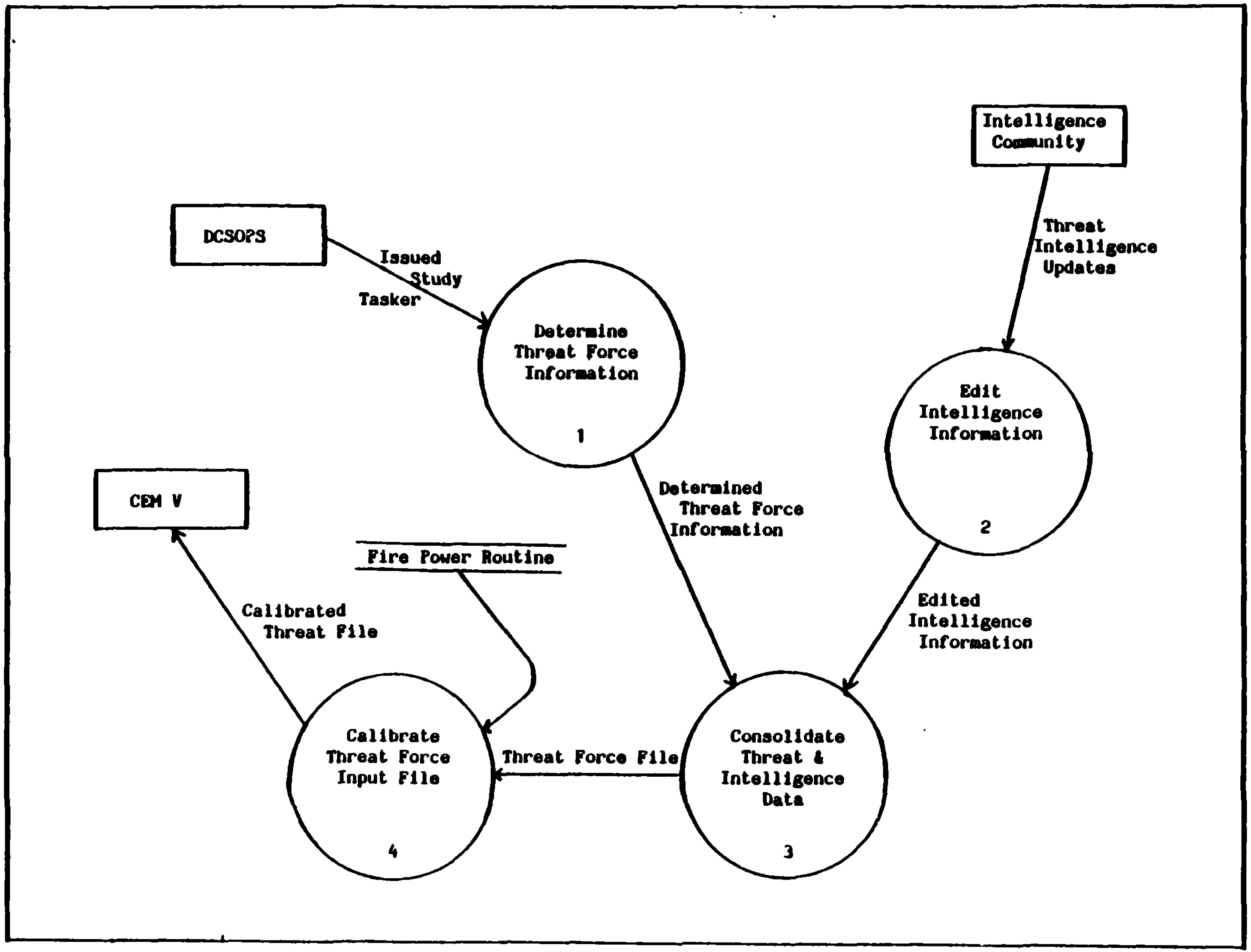


Figure C-1. Physical Overview DFD - RQ Study Team

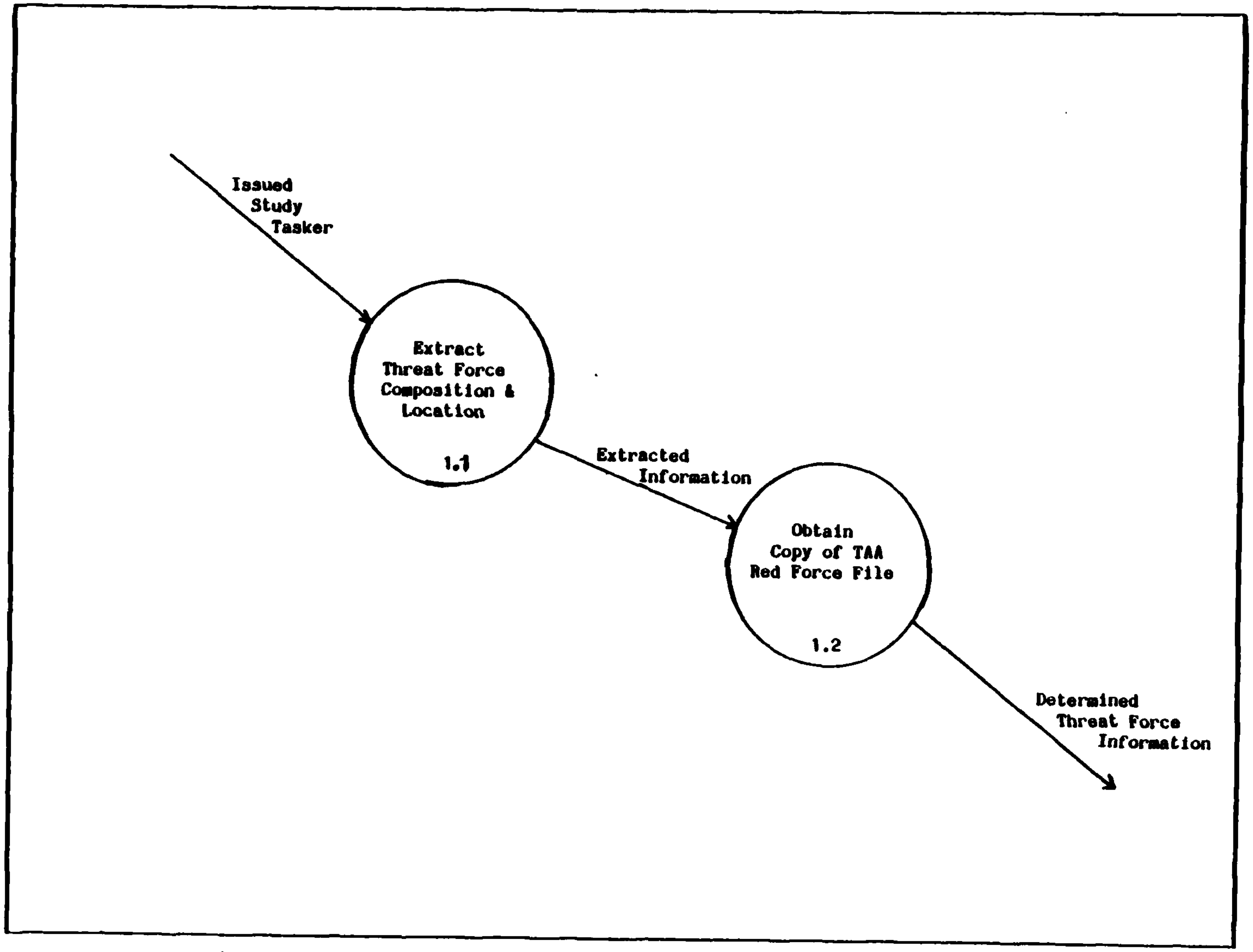
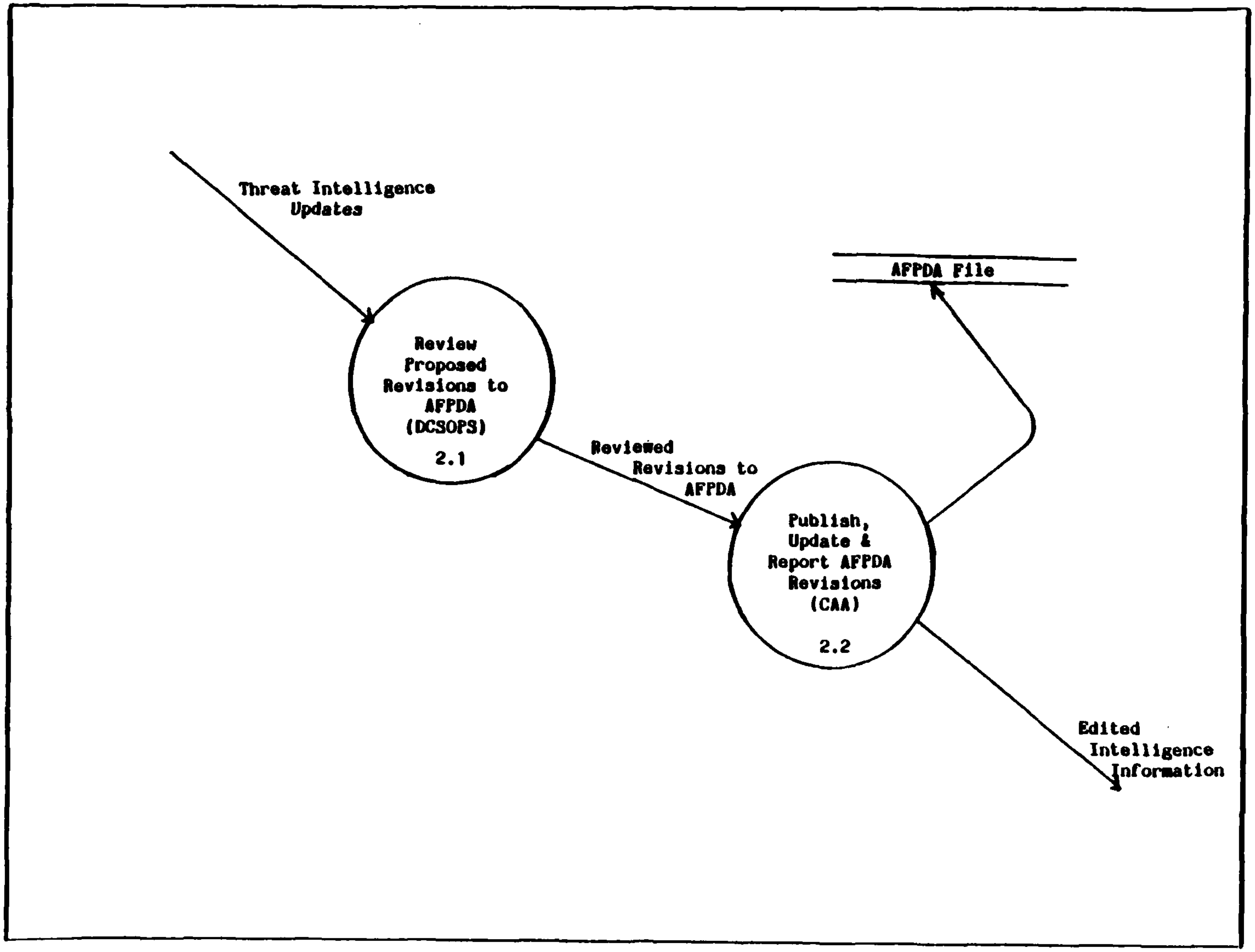


Figure C-2. Process 1, Physical DFD - RQ Study Team



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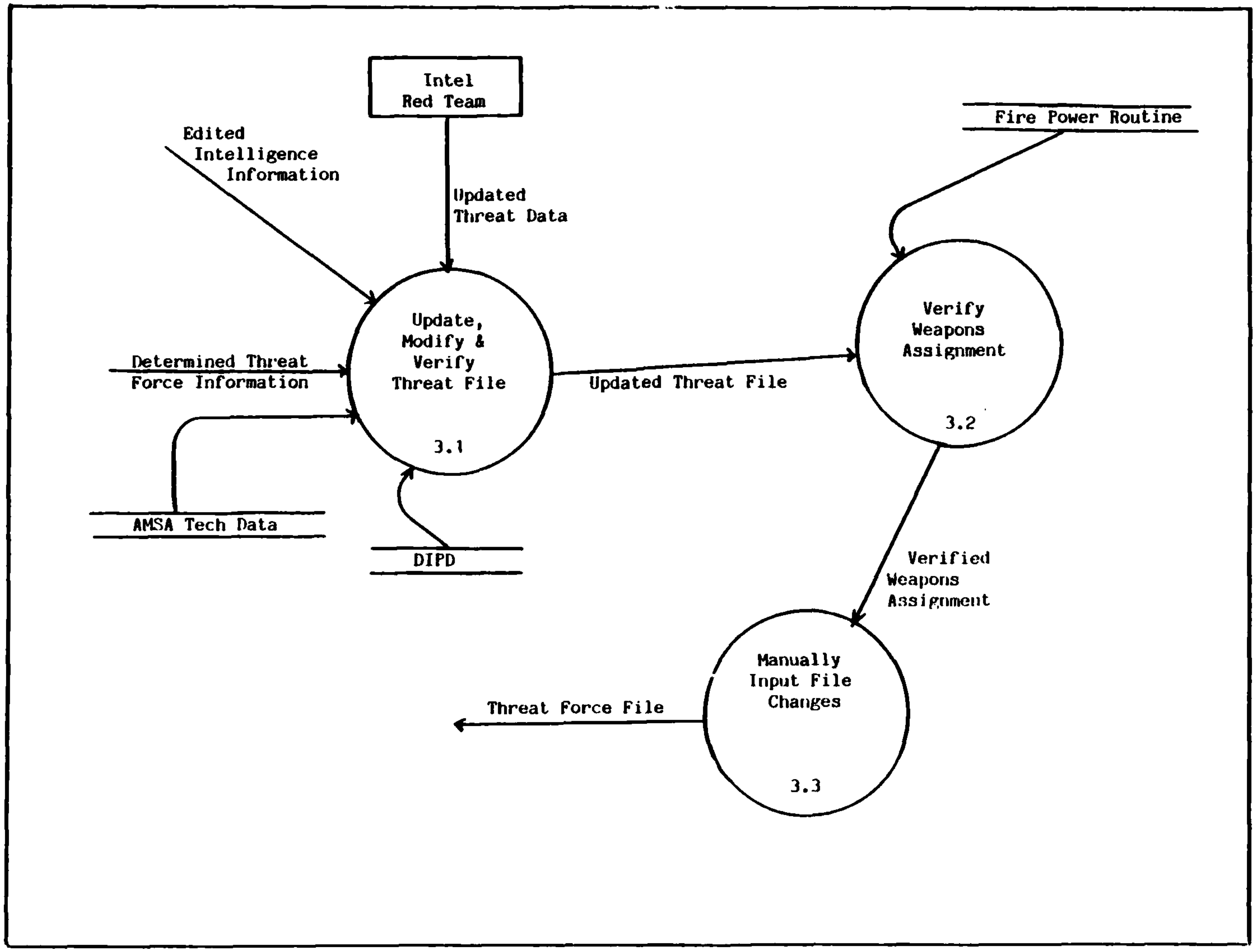


Figure C-4. Process 3, Physical DFD - RQ Study Team

Appendix D

Physical DFD's - IDOFOR Study Team

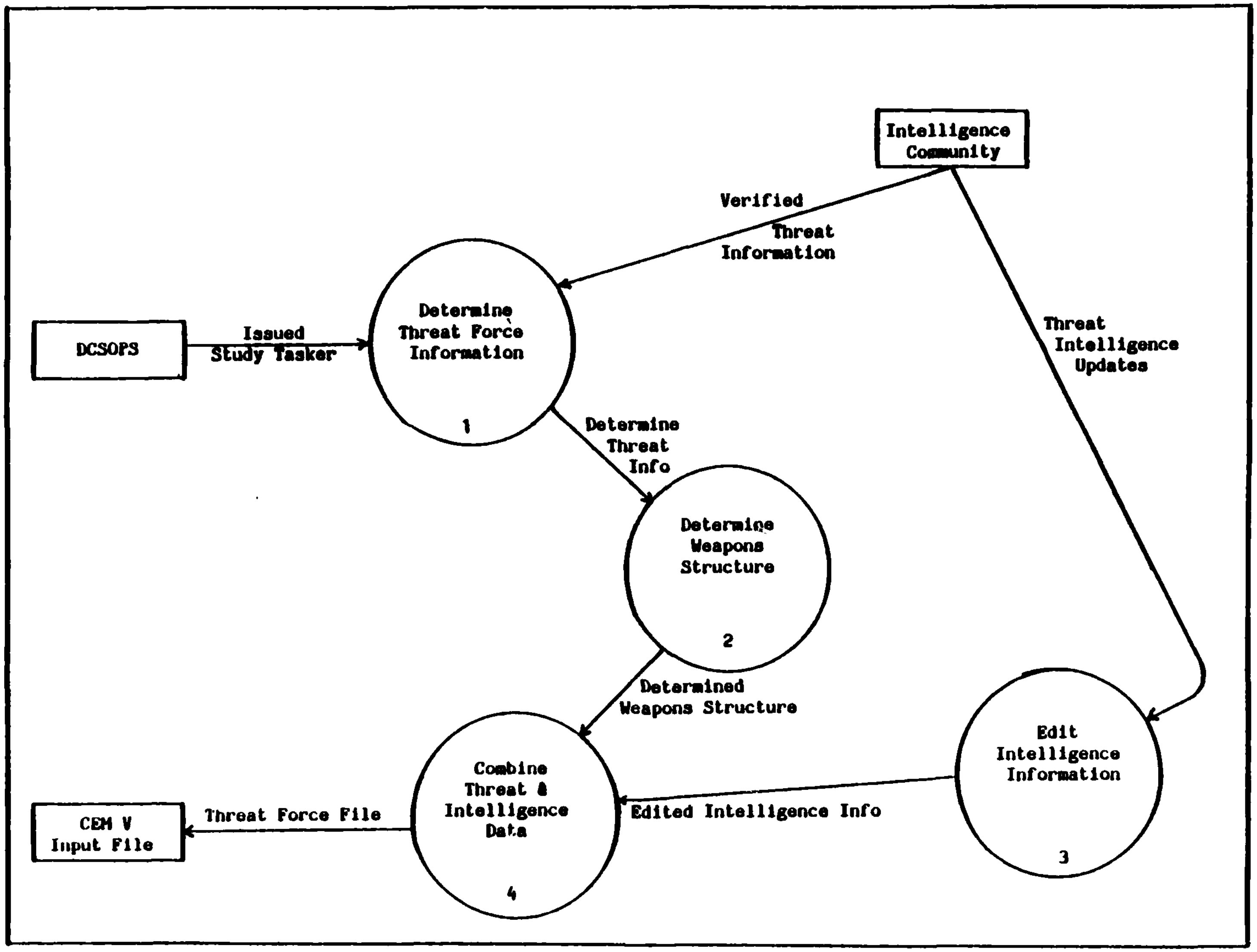


Figure D-1. Physical Overview DFD - IDOFOR Study Team

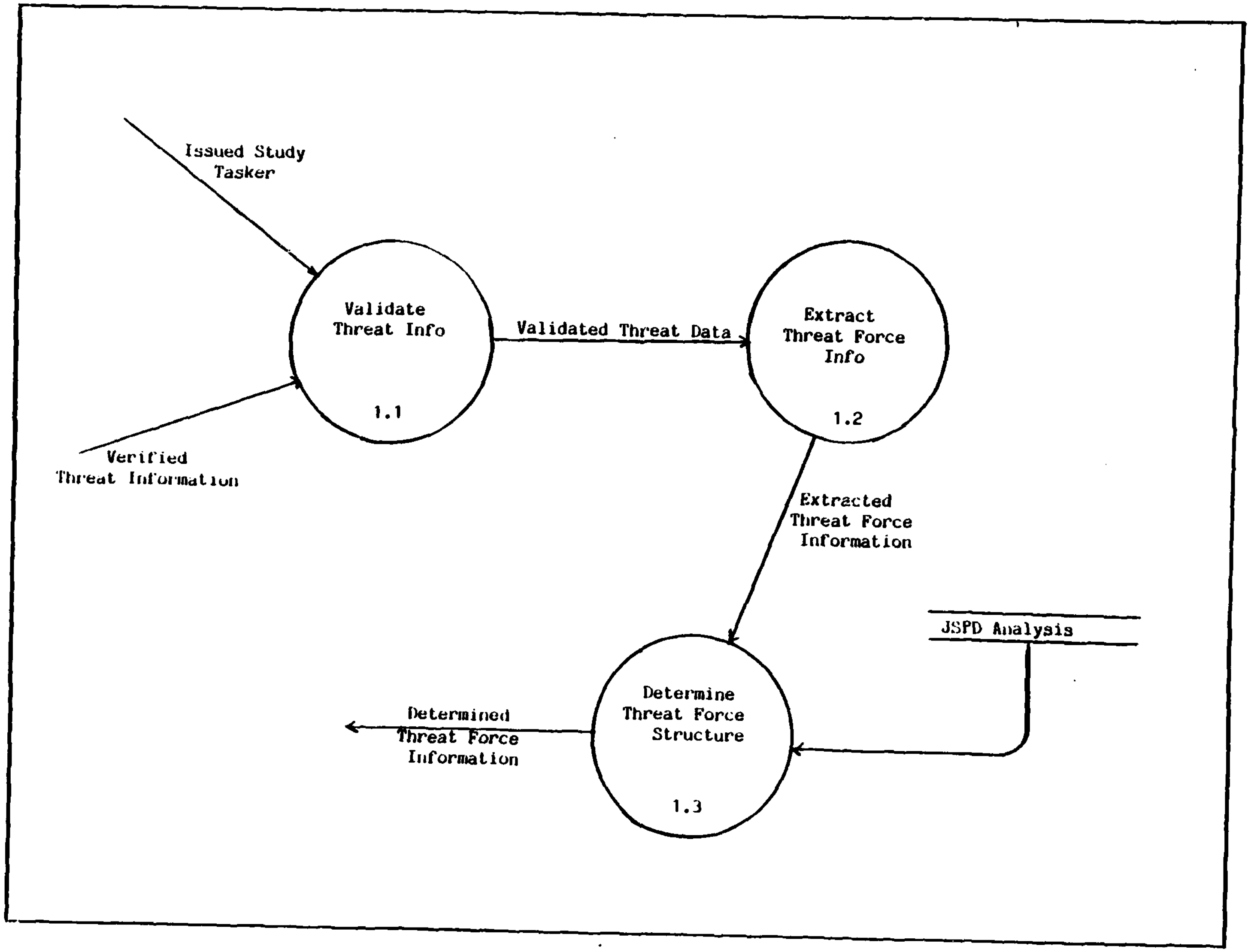


Figure D-2. Process 1, Physical DFD - IDOFOR Study Team

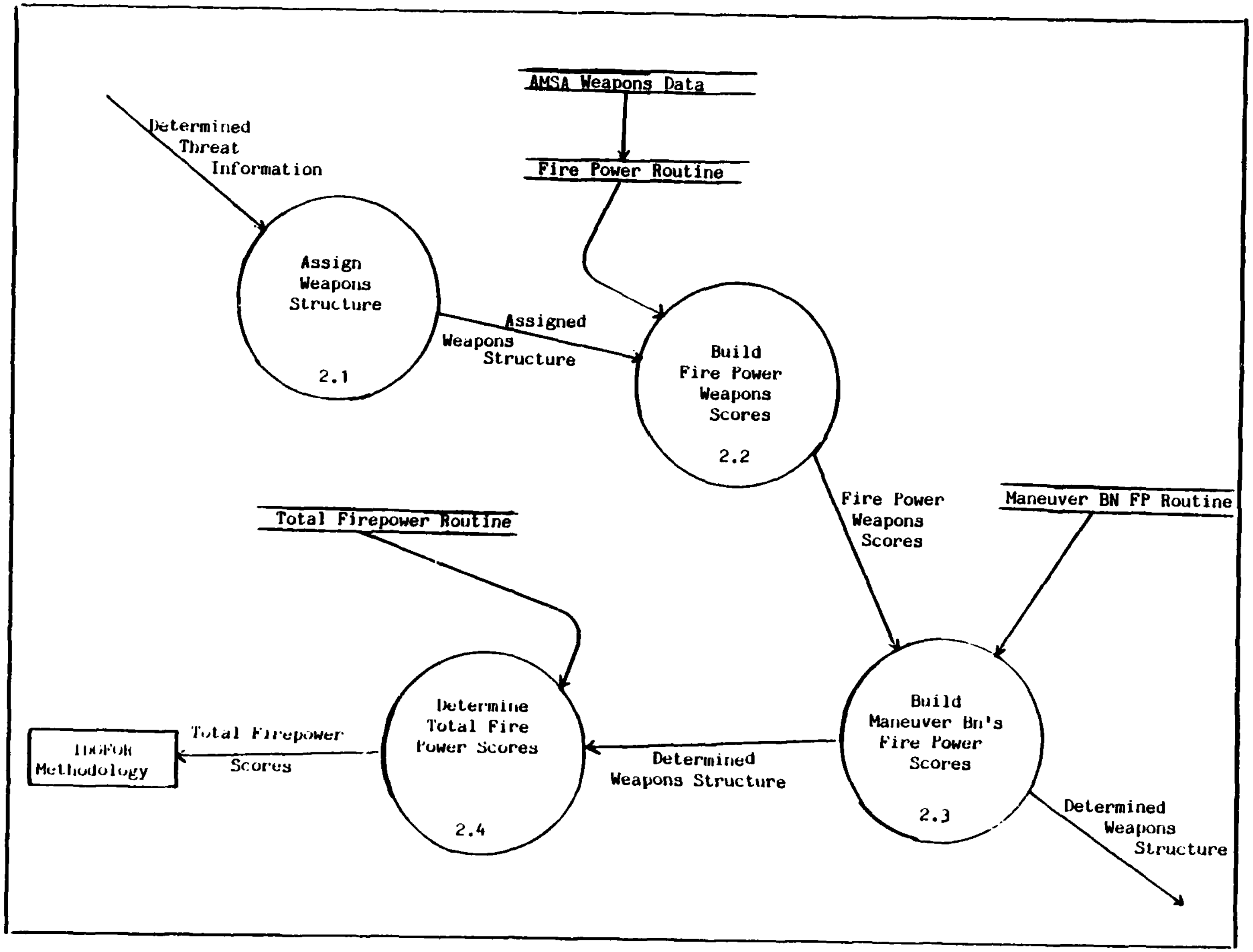


Figure D-3. Process 2, Physical DFD - IDOFOR Study Team

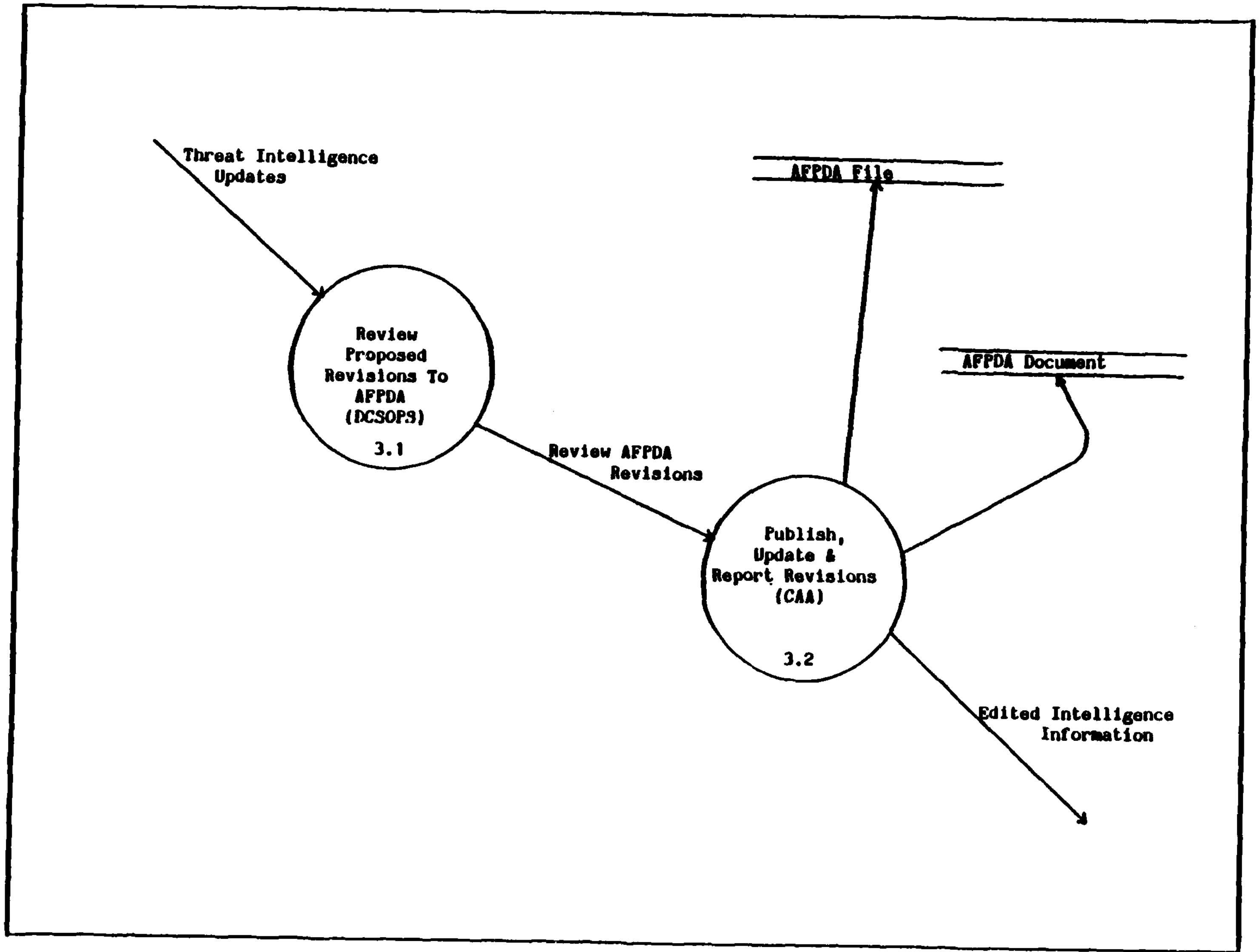


Figure D-4. Process 3, Physical DFD - IDOFOR Study Team

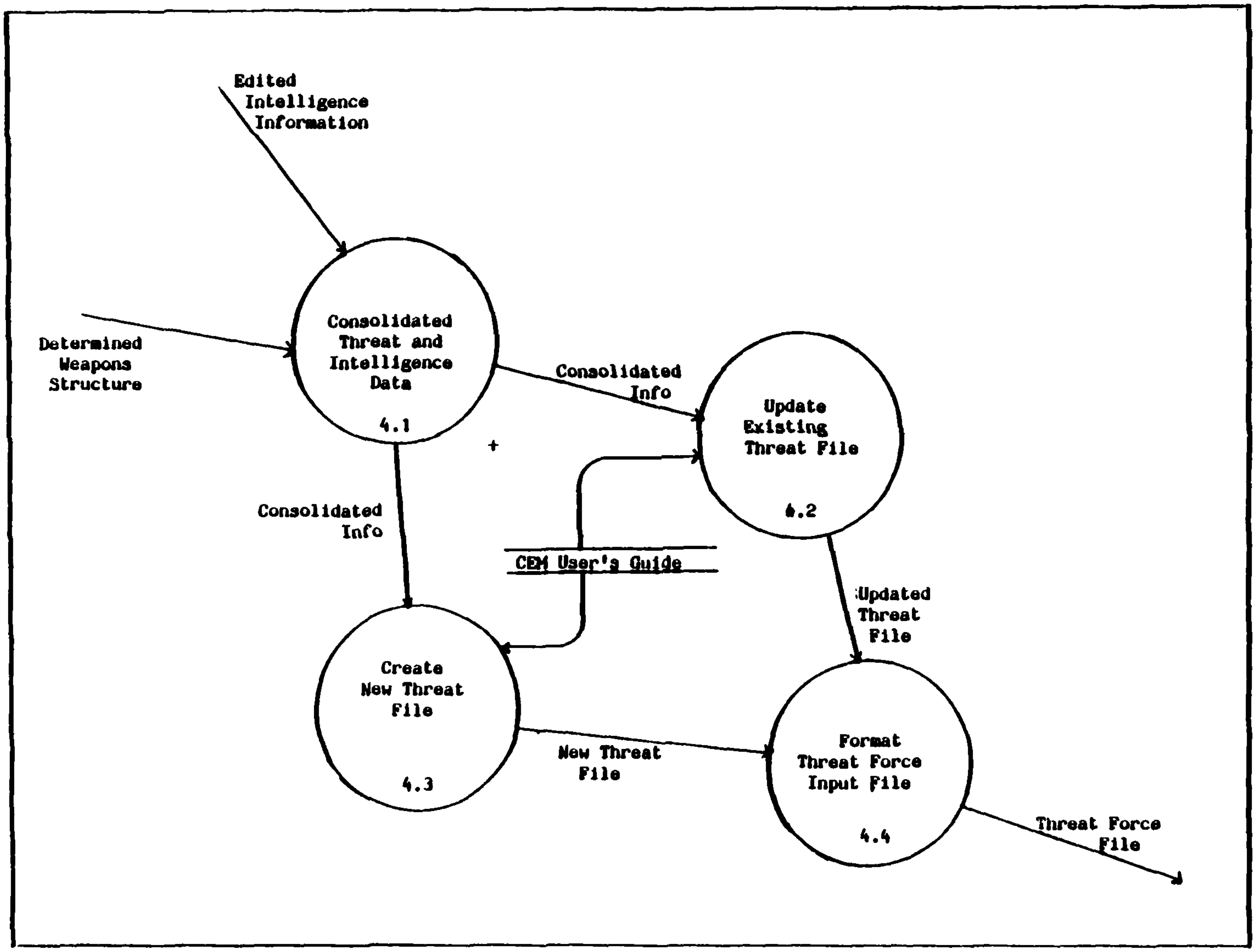


Figure D-5. Process 4, Physical DFD - IDOFOR Study Team

Appendix E

Logical DFD - All Study Teams

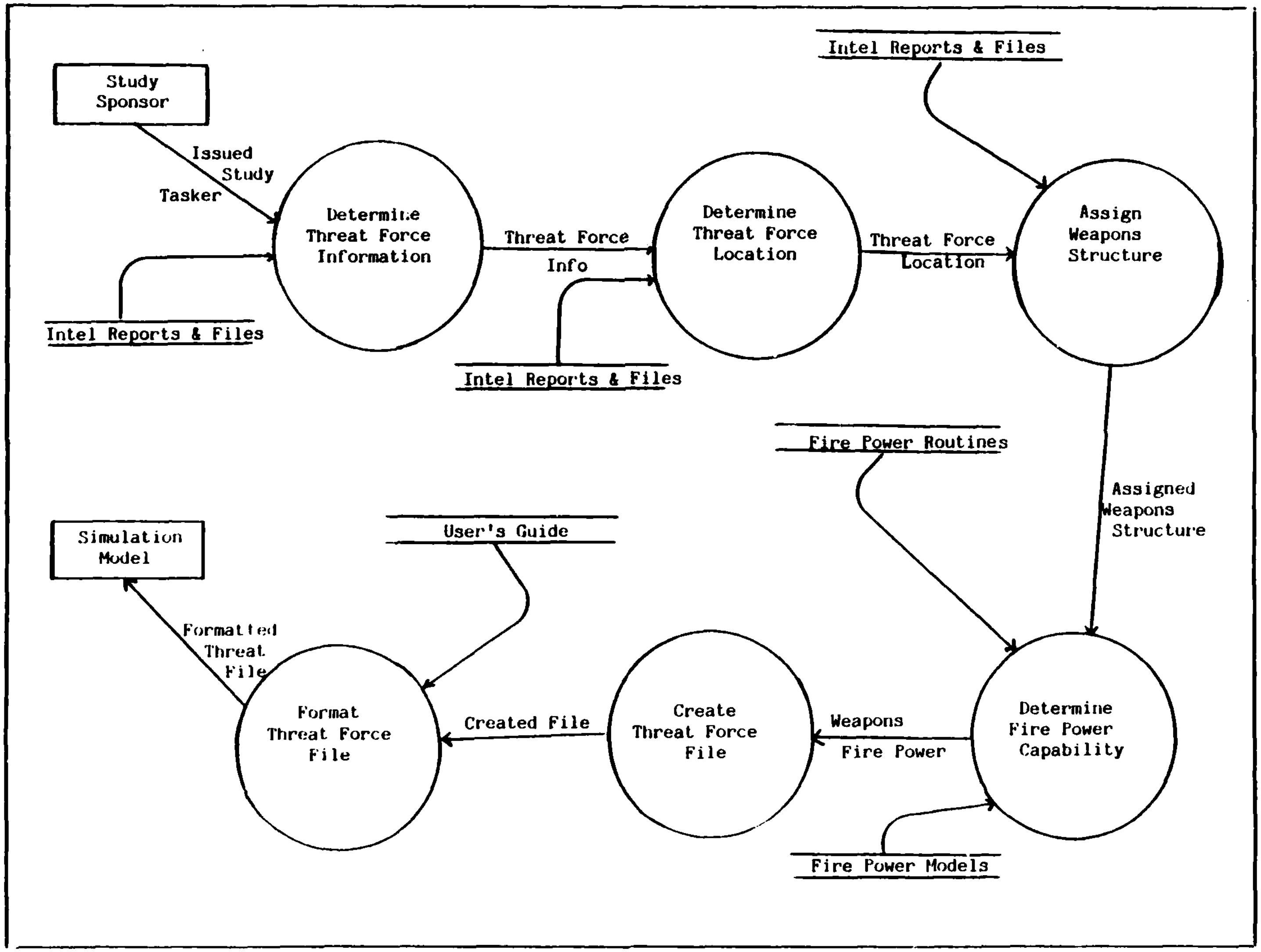


Figure 7. Logical DFD - All Study Teams

Appendix F

Proposed Logical DFD - All Study Teams

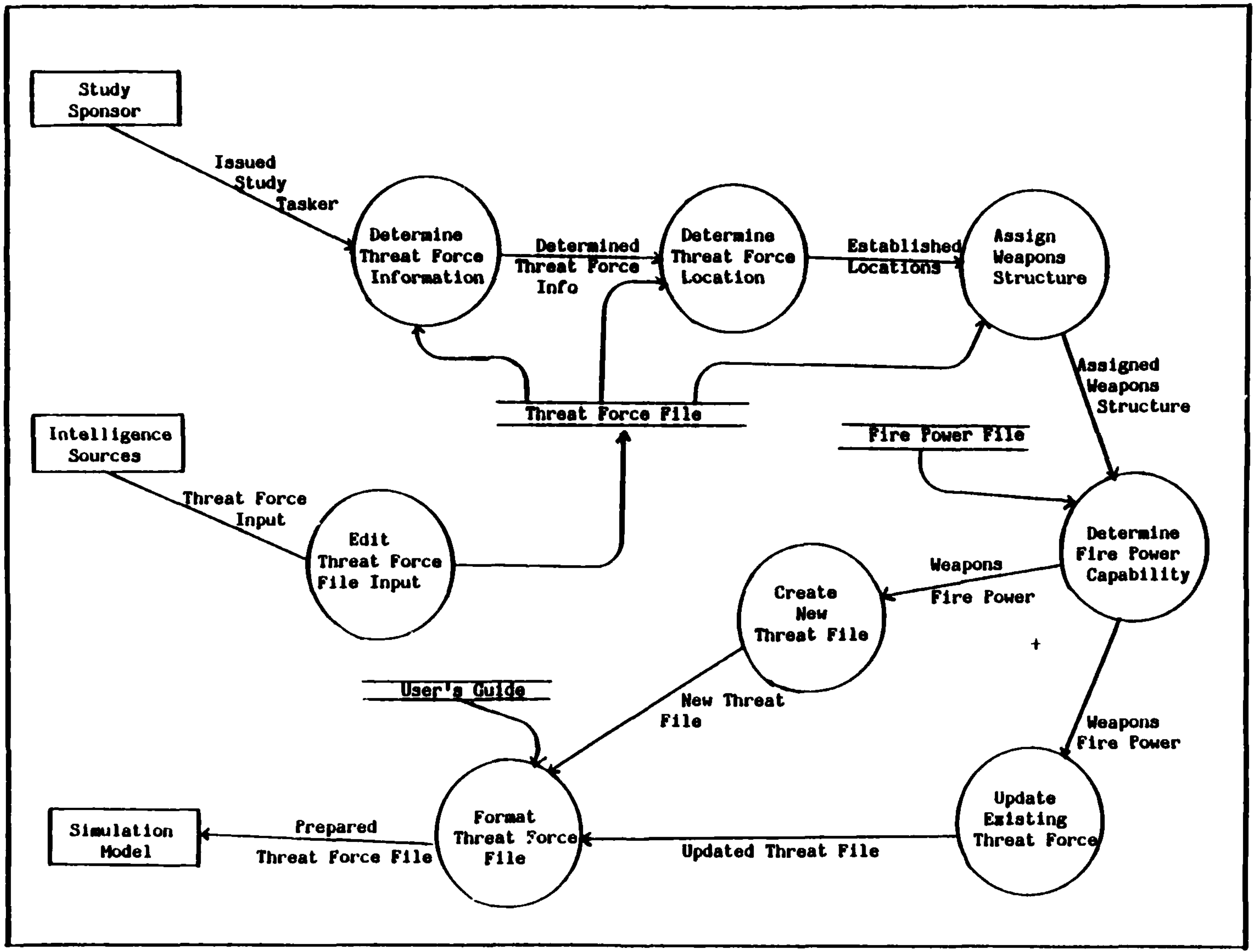


Figure 8. Proposed Logical DFD - All Study Teams

Appendix G

<u>Entities and Attributes</u>

Keys are indicated by the underlined attributes.

UNIT INFO	<u>unit name</u>, unit type, echelon, authorized strength
MISSION DATA	<u>mission type</u>
MISSION INFO	<u>unit name</u>, <u>theater cycle</u>, <u>mission type</u>
TIME	<u>theater cycle</u>
SUMMARY INFO	<u>theater cycle</u>, <u>nationality</u>, <u>side</u> FEBA change, # in-theater divisions, # in-theater GS Arty, # in-theater CAS, # in-theater aircraft, # tons Arty Ammo expended, # decimated divisions
NATIONALITY	<u>nationality type</u>
SIDE	<u>side type</u>
DECISION ESTIMATE	<u>theater cycle</u>, <u>unit name</u>, friendly FP #, enemy FP #, force ratio, current posture, decision
FEBA TRACE	<u>unit name</u>, <u>theater cycle</u>, <u>side</u>, <u>nationality</u>, low minisector value, high minisector value
FEBA INFO	<u>minisector value</u>
CONSUMABLE LOG INFO	<u>resource item</u>, resource category
LOGISTICS EXPERIENCE INFO	<u>theater cycle</u>, <u>side</u>, <u>nationality</u>, <u>resource item</u>, <u>unit name</u>, # authorized, # on-hand, # gains to theater stocks from resupply, # gains to theater stocks from repair, # items in repair, # items lost to combat, # items temporary lost to non-combat, # items permanently lost to non-combat, # items temp lost to maintenance,
LOST/CAUSE	<u>theater cycle</u>, <u>side</u>, <u>nationality</u>, <u>resource</u>, <u>item</u>, <u>unit name</u>, # items engaged, # hit by tank, # hit by APC, # hit by AT/M, # hit by HELOS, # hit by ARTY, # hit by CAS

AIR INFO	<u>theater cycle</u>, <u>side</u>, <u>nationality</u>, <u>unit name</u>, # primary TAC fighters, # sancturary TAC fighters, # A/D fighers, fighters, % TAC fighters, AR/I, % TAC fighters CA, % TAC fighters CAS, # primary aircraft destroyed on ground, # aircraft destroyed
CASUALTY INFO	<u>theater cycle</u>, <u>side</u>, <u>nationality</u>, <u>unit name</u>, # infantry engaged, # infantry KIA, # infantry CMIA, # crews engaged, # crews KIA, # crews WIA, # casualties DNBI, # casualties DNBIK, # casualties hospital, # casualties evacuated

Appendix H

Relationships Between Entities

RELATIONSHIP	MAPPING PROPERTY
Casualties by Time	1 : N between Time and Casualty Info
Casualties by Side	1 : N between Side and Casualty Info
Casualties by Nationality	1 : N between Nationality and Casualty Info
Unit Casualties	1 : N between Unit Info and Casulty Info
Theater Units	1 : N between Time and Unit Info
Force Units	1 : N between Side and Unit Info
Unit Nationality	1 : N between Nationality and Unit Info
Theater Air Force	1 : N between Time and Air Info
Opposing Air Forces	1 : N between Side and Air Info
Nationality Air Forces	1 : N between Nationality and Air Info
Unit Air Forces	1 : N between Unit Info and Air Info
Theater Log Lost/Cause	M : N between Time and Consumable Resource Info
Opp Forces Log Lost/Cause	M : N between Side and Consumable Resource Info
Nation Log Lost/Cause	M : N between Nationality and Consumable Resource Info
Unit Log Lost/Cause	M : N between Unit Info and Consumable Resource Info
Theater Log Experience	M : N between Time and Consumable Resource Info
Nation Log Experience	M : N between Nationality and Consumable Resource Info
Opp Forces Log Experience	M : N between Side and Consumable Resource Info
Unit Log Experience	M : N between Unit Info and Consumable resource Info
FEBA Trace by Time	M : N between Time and FEBA Info
FEBA Trace by Side	M : N between Side and FEBA Info
FEBA Trace by Nationality	M : N between Nationality and FEBA Info
FEBA Trace by Unit	M : N between Unit Info and FEBA Info
Unit Decision Estimate	1 : N between Unit Info and Decision Estimate
Theater Decision Estimate	1 : N between Time and Decision Estimate
Theater Summary	1 : N between Time and Summary Info
Theater Forces Summary	1 : N between Side and Summary Info
Theater Nationality Summary	1 : N between Nationality and Summary Info
Theater Missions	M : N between Time and Mission Data
Unit Missions	M : N between Unit Info and Mission Data

Appendix I

Data Processing Requirements

The following questions are data processing requirements developed from interviews with the four major study teams at USACAA.

CURRENT PROCESSING REQUIREMENTS

1. What is the cummulative FEBA lost?

2. What are the casualties? per day? total?

3. What are the equipment losses? by weapon system? by time? by totals?

4. What is the resource consumption? equipment? personnel? ammo? by day? by equipment item? by time?

5. When are command decisions made? type of decision?

6. What is the FEBA trace? by day?

7. What are the amounts of consumables available vs already consumed? equipment type? ammo? POL? personnel? by time?

8. What are the permanent/temporary losses for specific resource items? equipment type? POL? ammo? personnel? total? by time?

9. What is the logistic summary? by day? total?

10. What is the daily combat loss/consumption? by major equipment item? by day? total?

11. What are the minor, major, severe, and chronic resource items? by weapons sytem type? by personnel? by time? total?

12. What is the total resupply vs losses? by equipment item? by weapons system?

13. How many crew KIA/WIA vs specific weapons sytem?

14. How many repairable tanks/light armor? by cycle? total?

15. How many non-crew KIA/WIA? by cycle? cause? total?

16. What is the specific movement of the FEBA? by minisector?

17. What is the posture of a particular unit?

18. How many times did a unit attack vs delay/defend?

FUTURE PROCESSING REQUIREMENTS

1. What are the factors that led to specific command decision? unit status? enemy estimates? units involved? firepower estimates?

2. How much time does a particular unit spend a specific posture?

3. What does the lost vs cause look like for a specific weapons system? by time?

Appendix J

Entity - Relationship Diagrams

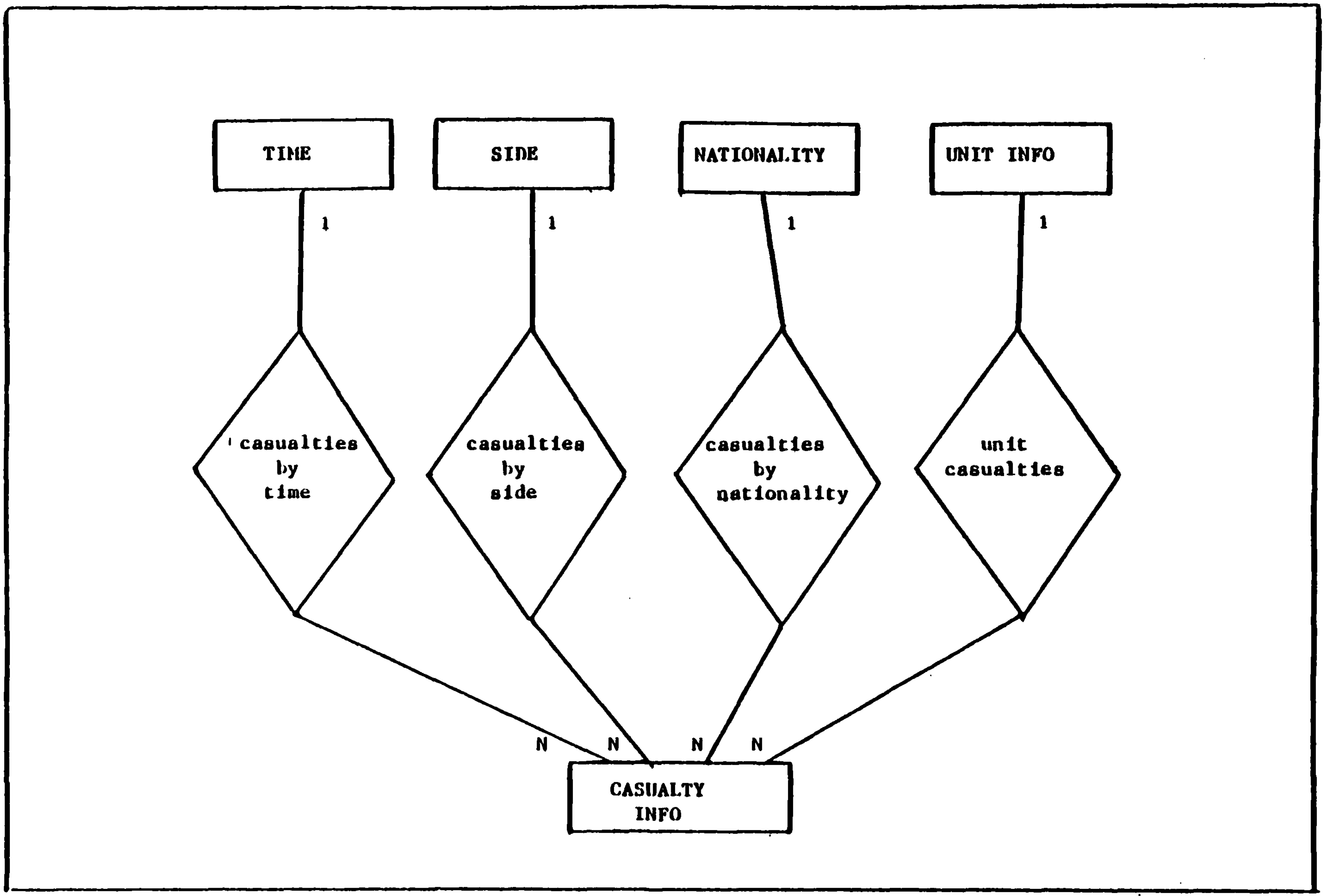


Figure J-1. Entity-Relationship Diagram : Casualties

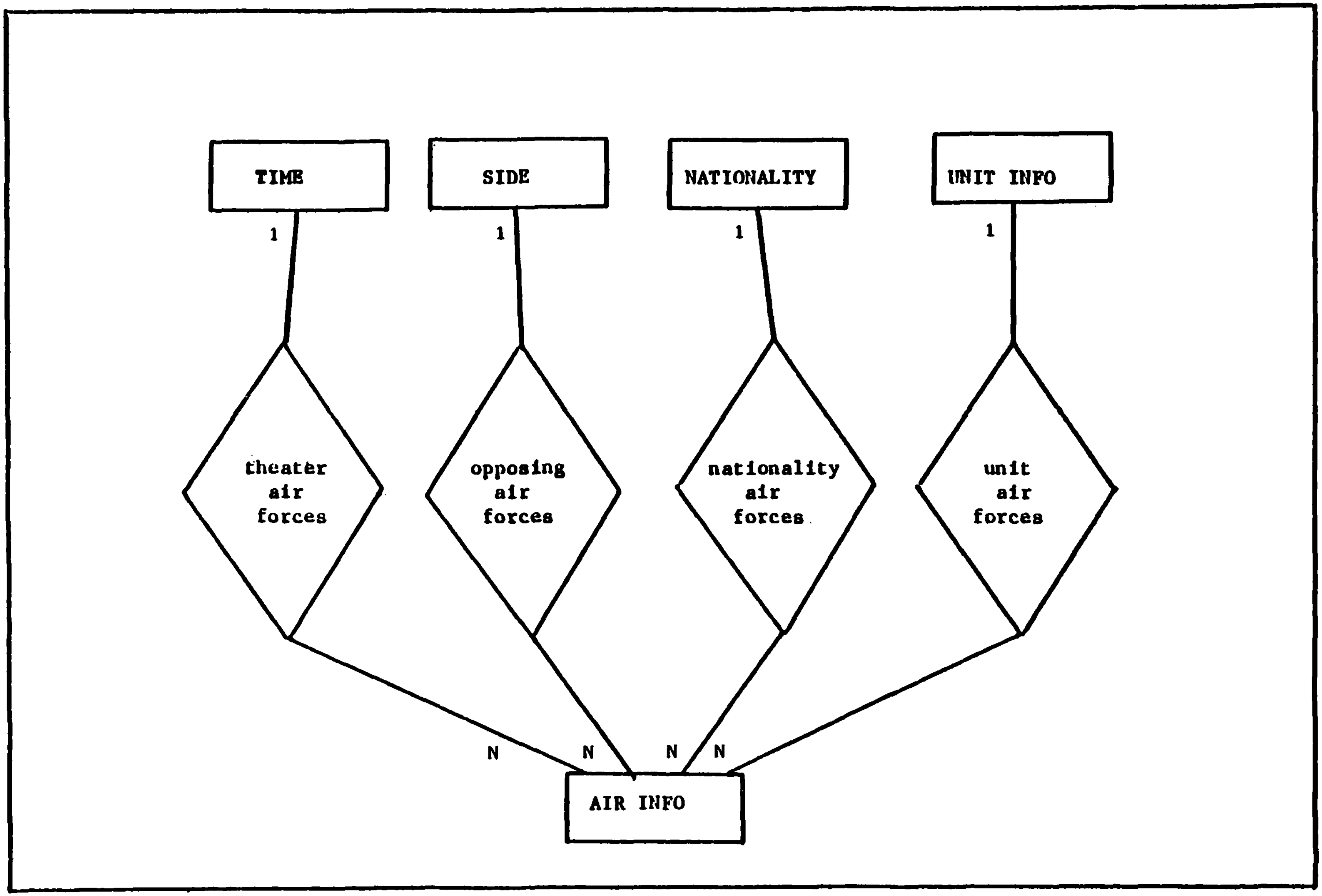


Figure J-2. Entity-Relationship Diagram : Tactical Air

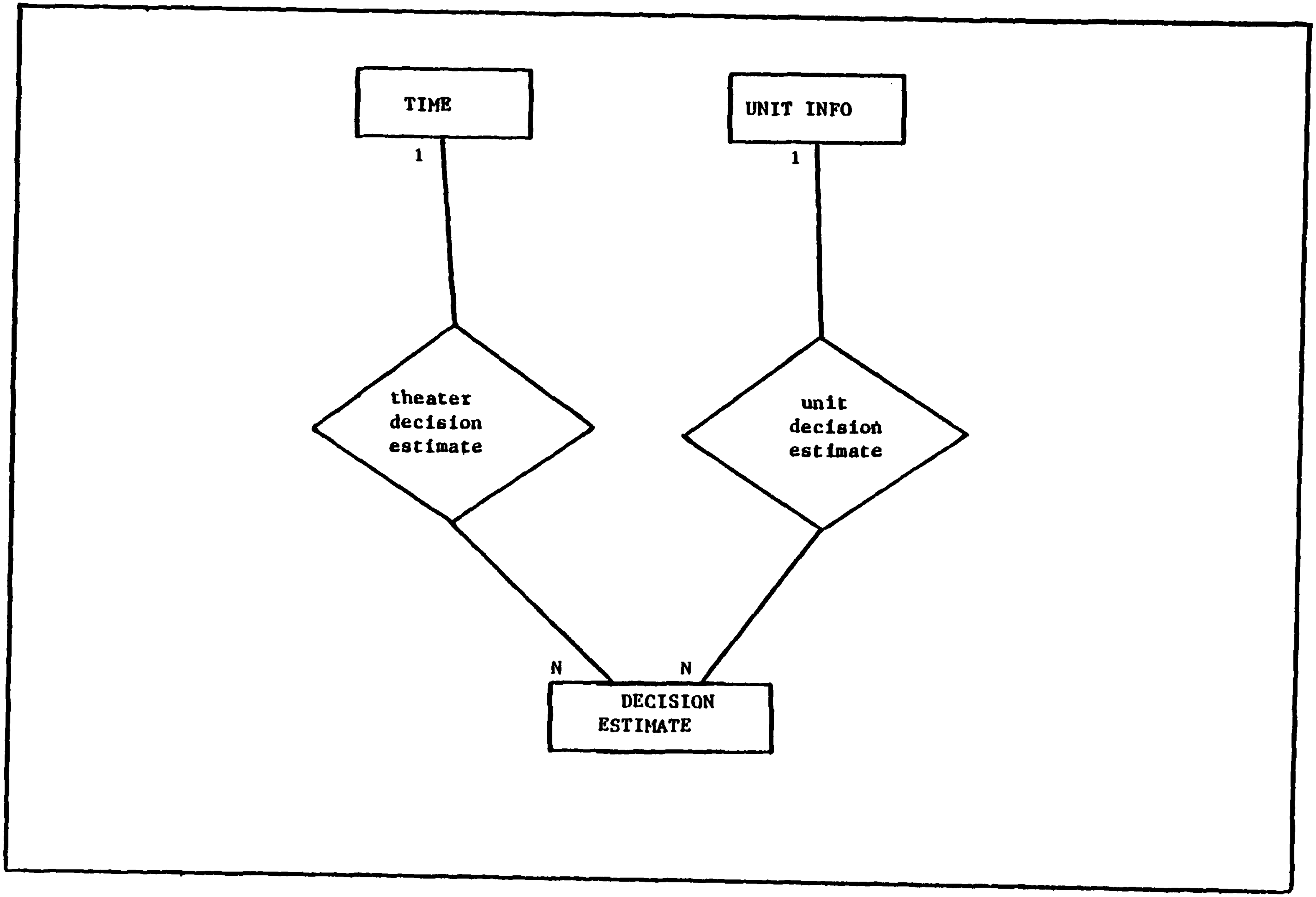


Figure J-3. Entity-Relationship Diagram : Tactical Decisions

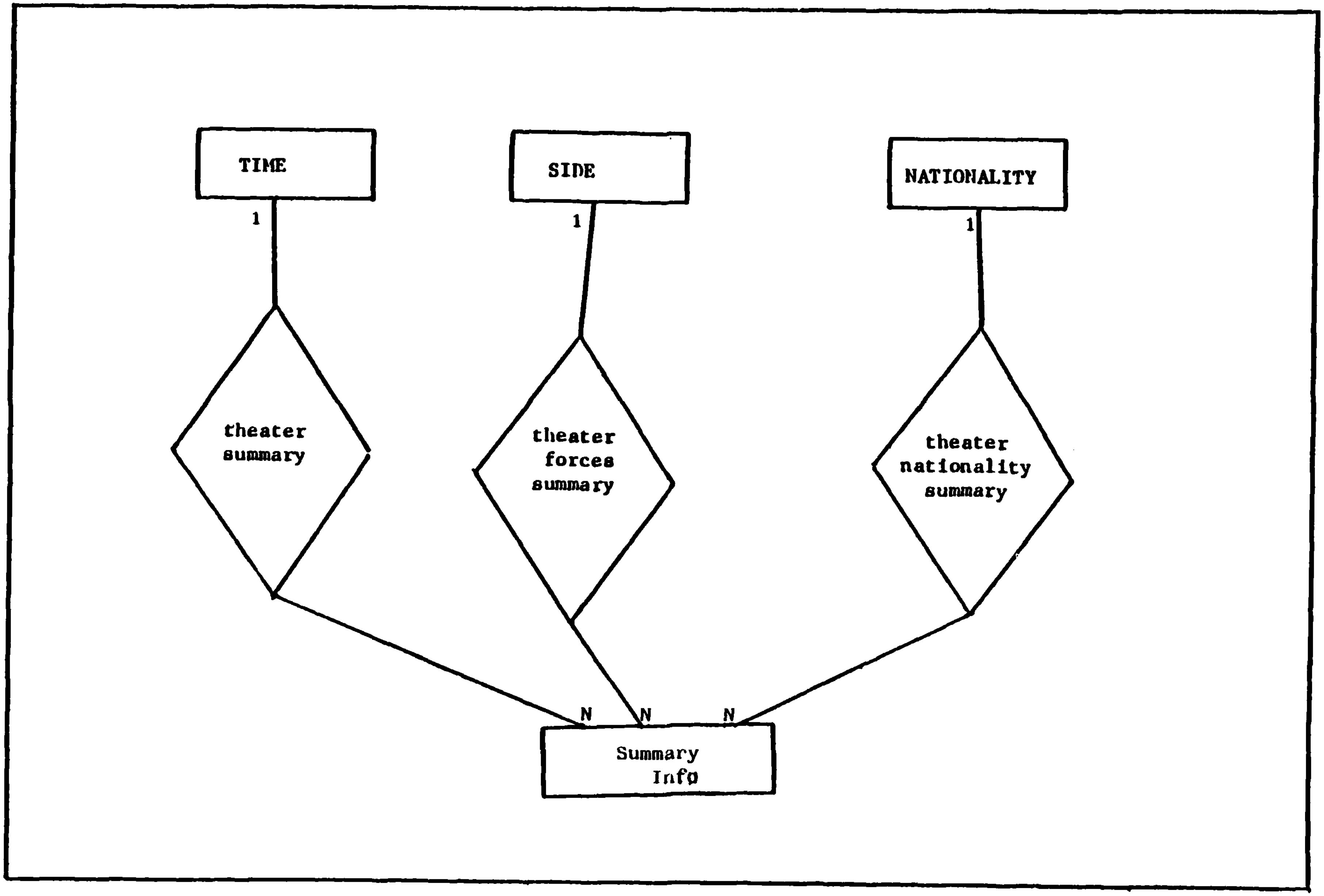


Figure J-4. Entity-Relationship Diagram : War Summary

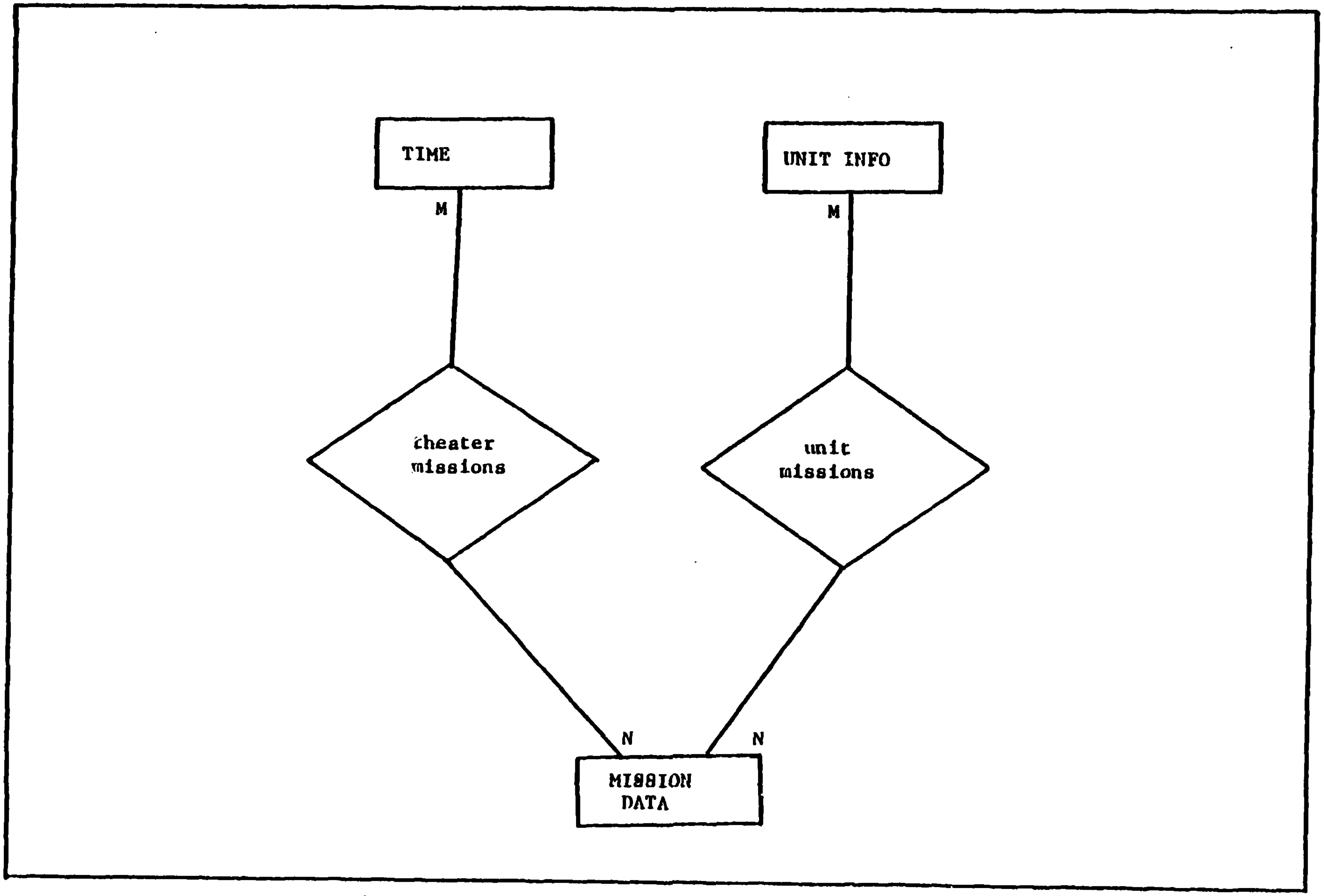


Figure J-5. Entity-Relationship Diagram : Mission

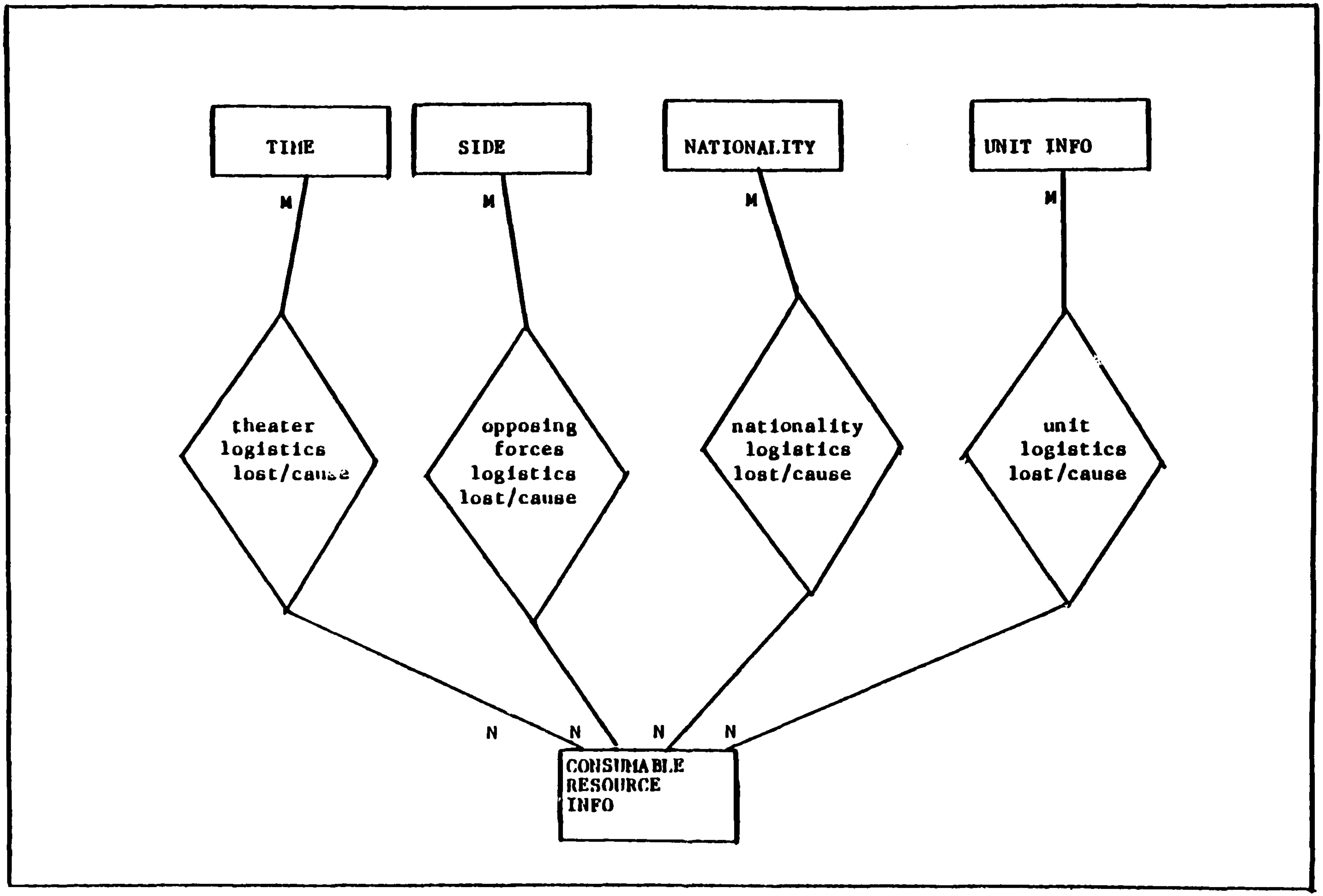


Figure J 6. Entity-Relationship Diagram : Logistics Lost/Cause

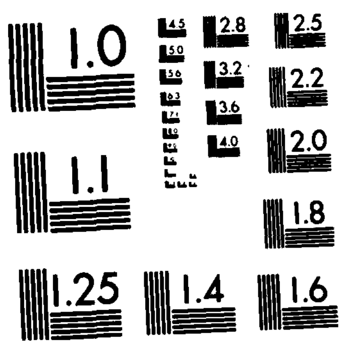
AD-A124 891 CONCEPTS EVALUATION MODEL V INPUT-DATA SYSTEM(U) AIR FORCE INST OF TECH WRIGHT-PATTERSON AFB OH SCHOOL OF ENGINEERING J D HIGHTOWER DEC 82 AFIT/GCS/EE/82D-18 2/2

UNCLASSIFIED F/G 9/2 NL

END

FILMED

DTIC



MICROCOPY RESOLUTION TEST CHART
NATIONAL BUREAU OF STANDARDS-1963-A

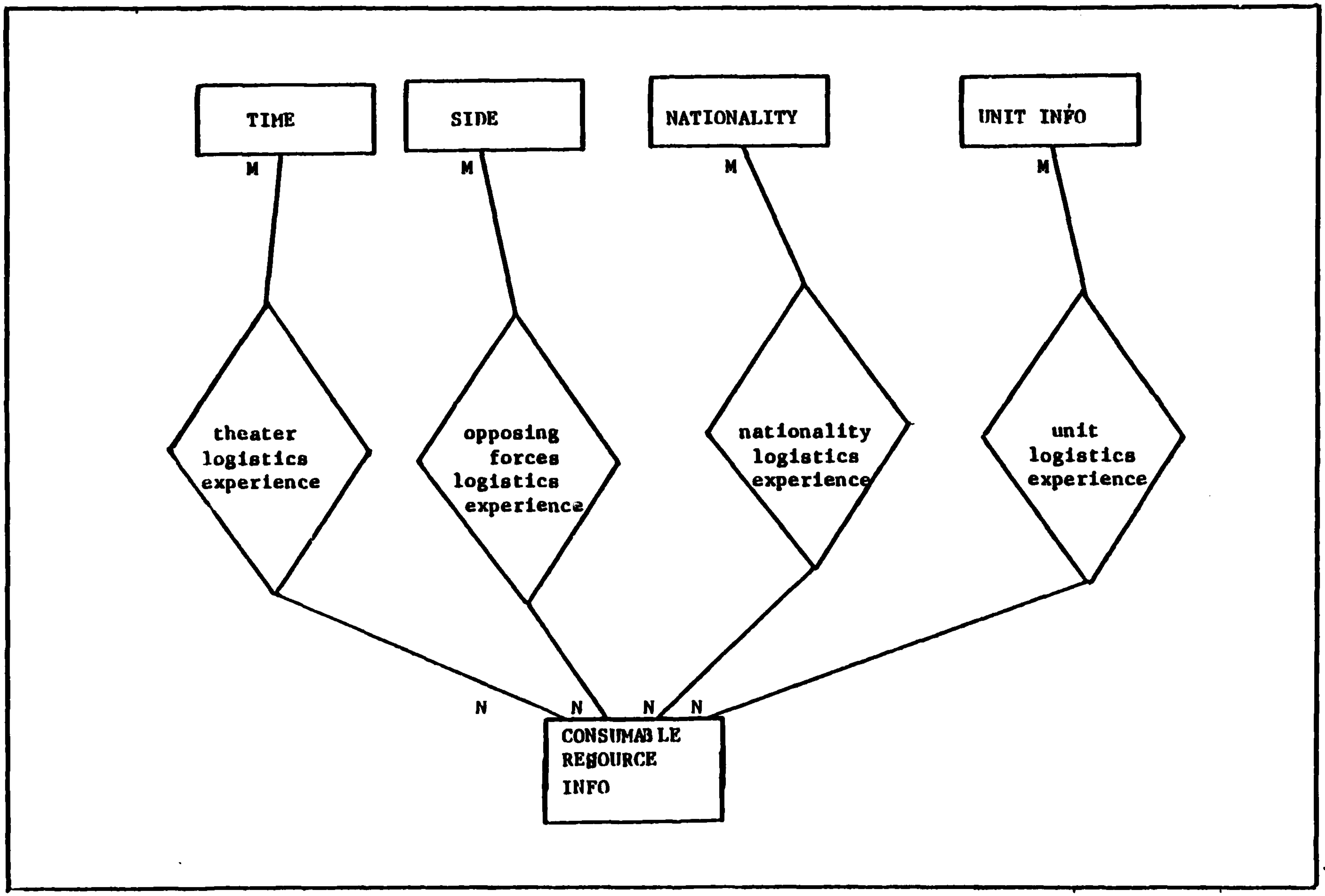


Figure J-7. Entity-Relationship Diagram : Logistics Experience

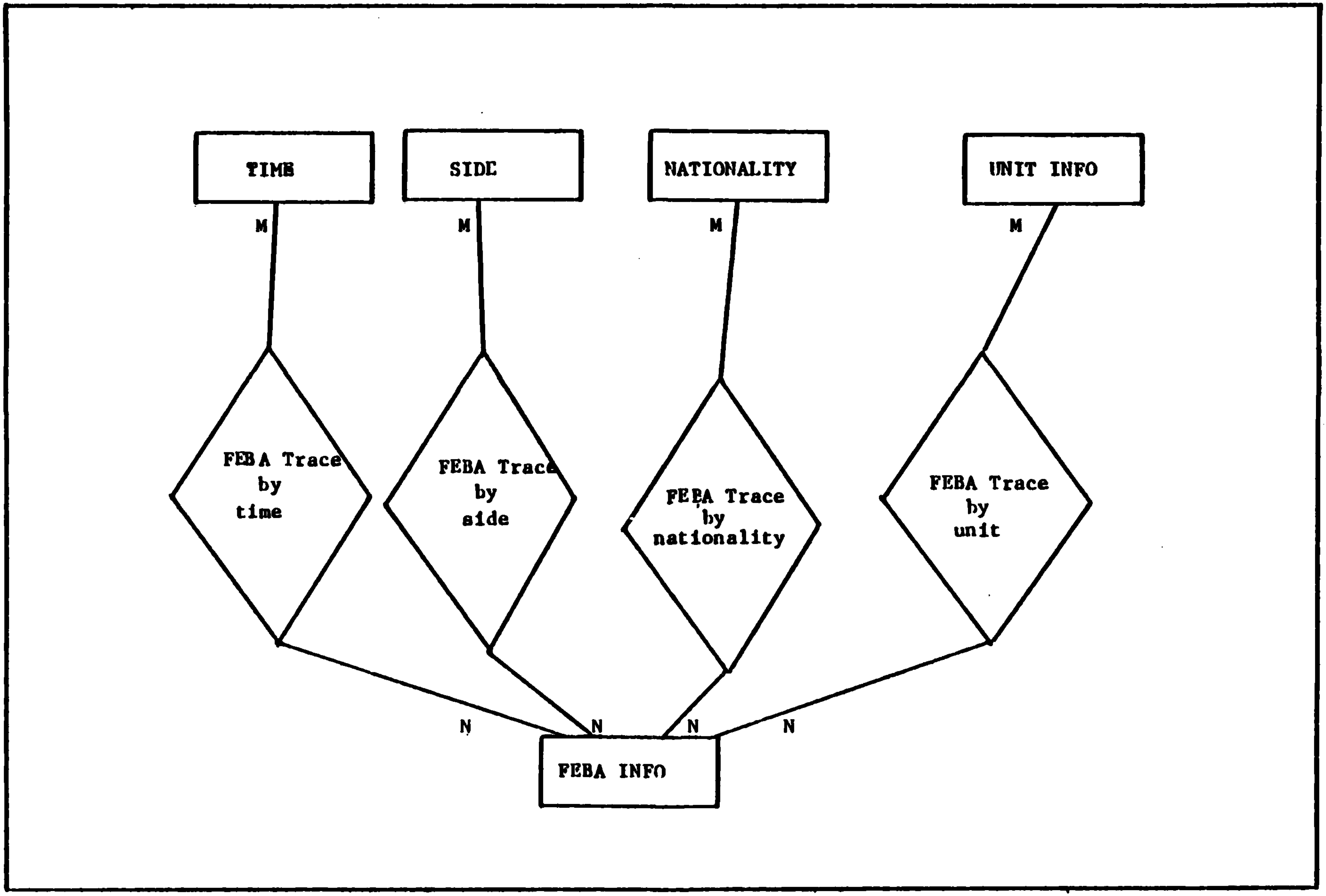


Figure J-8. Entity-Relationship Diagram : FEBA Data

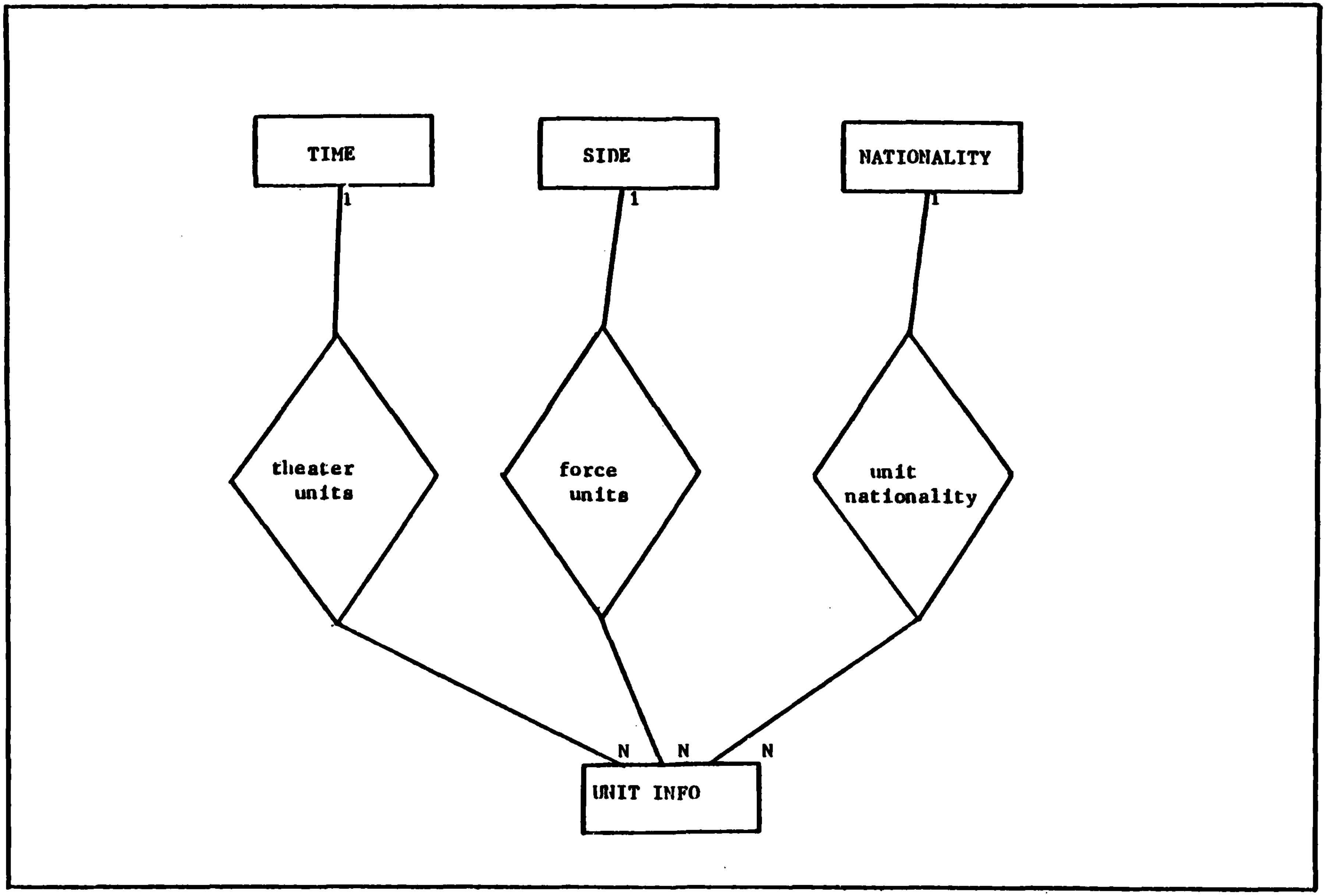


Figure J-9. Entity-Relationship Diagram : Unit Data

Appendix K

<u>Logical Schema (Network) - Global Structure</u>

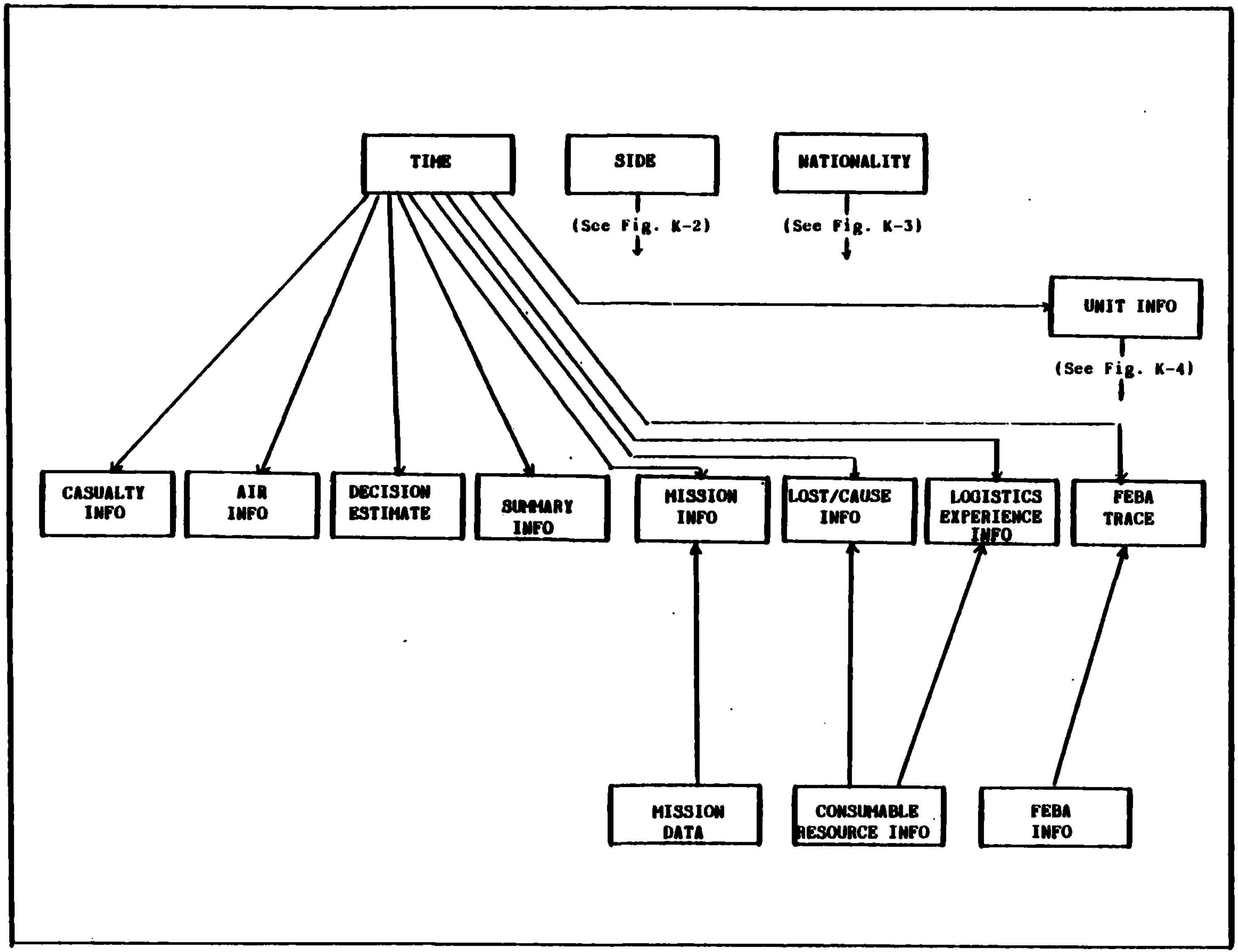


Figure K-1. Logical Schema (Network) - Global Structure

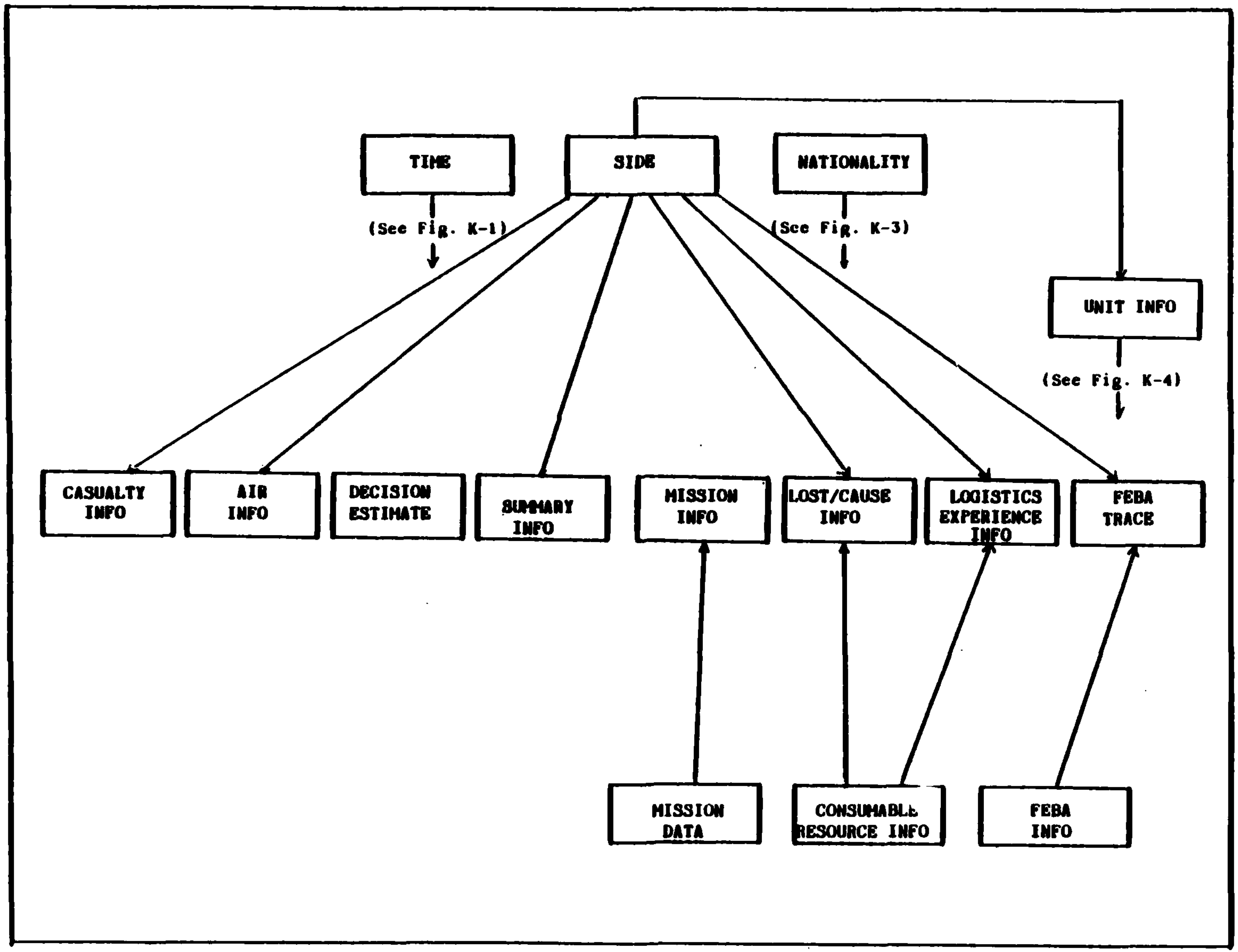


Figure K-2. Logical Schema (Network) - Global Structure Cont.

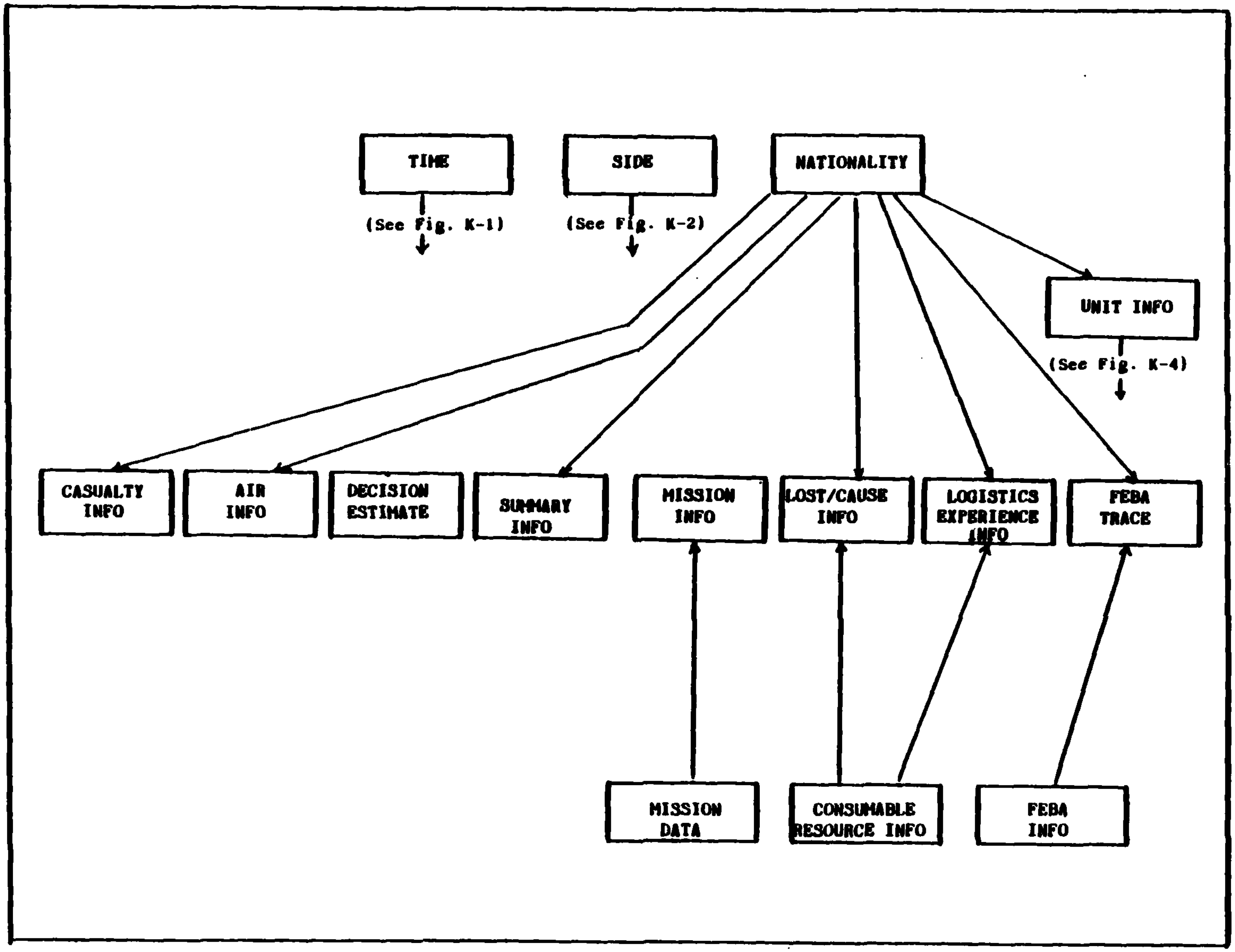


Figure K-3. Logical Schema (Network) - Global Structure Cont.

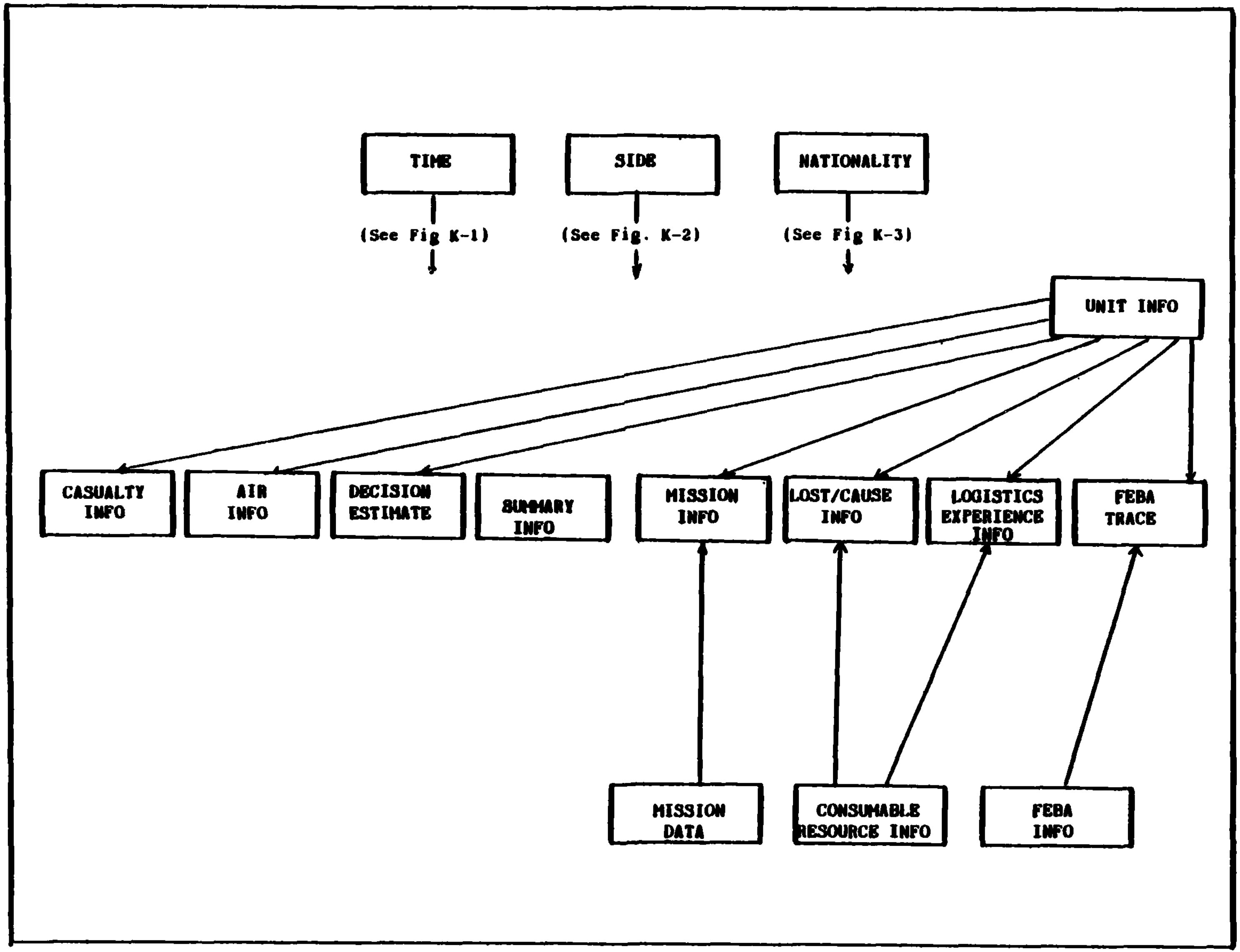


Figure K-4. Logical Schema (Network) - Global Structure Cont.

Appendix L

Model-Specific (Network) Logical Schemas

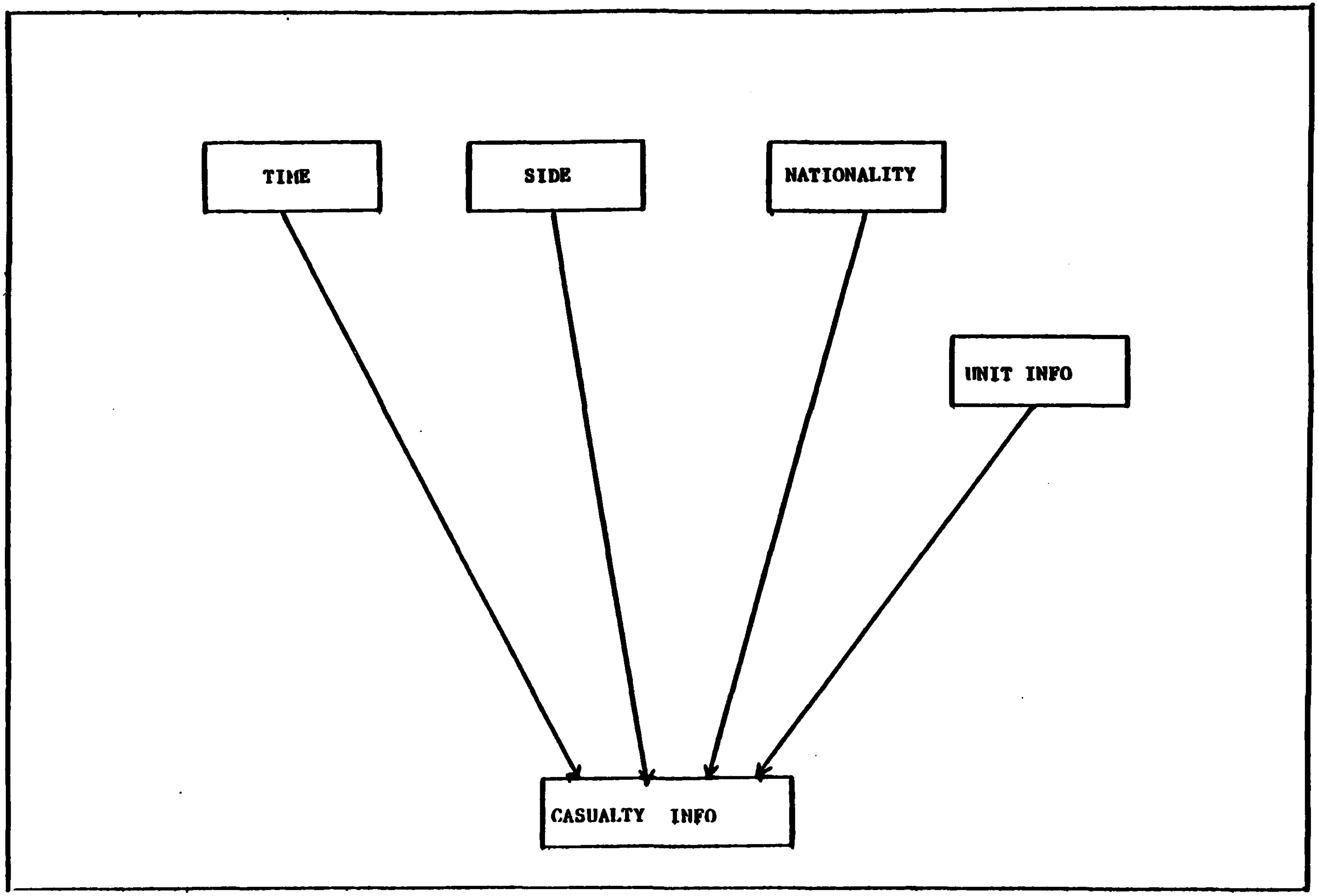


Figure L-1. Logical Schema (Network) Diagram : Casualties

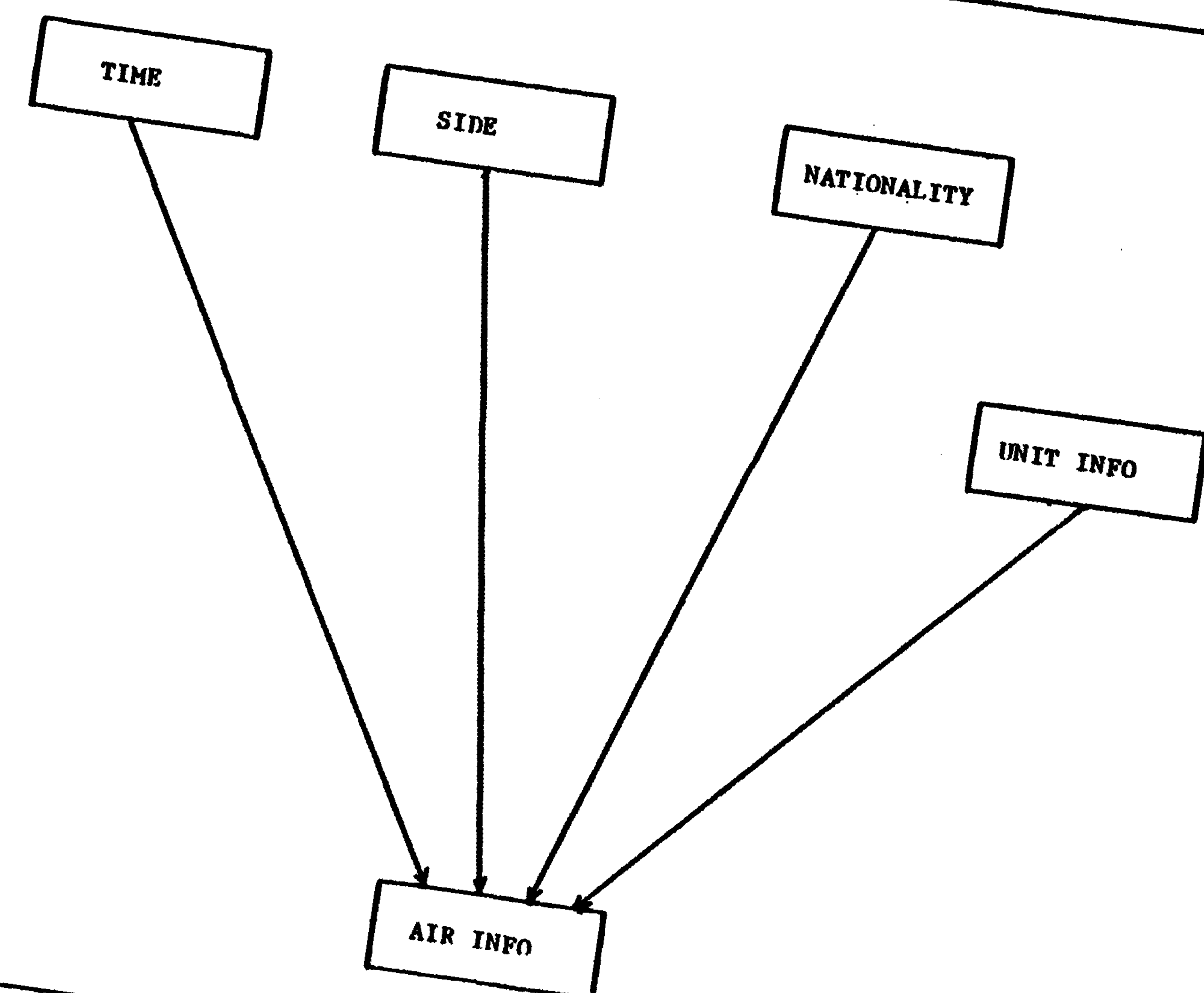


Figure L-2. Logical Schema (Network) Diagram : Tactical Air

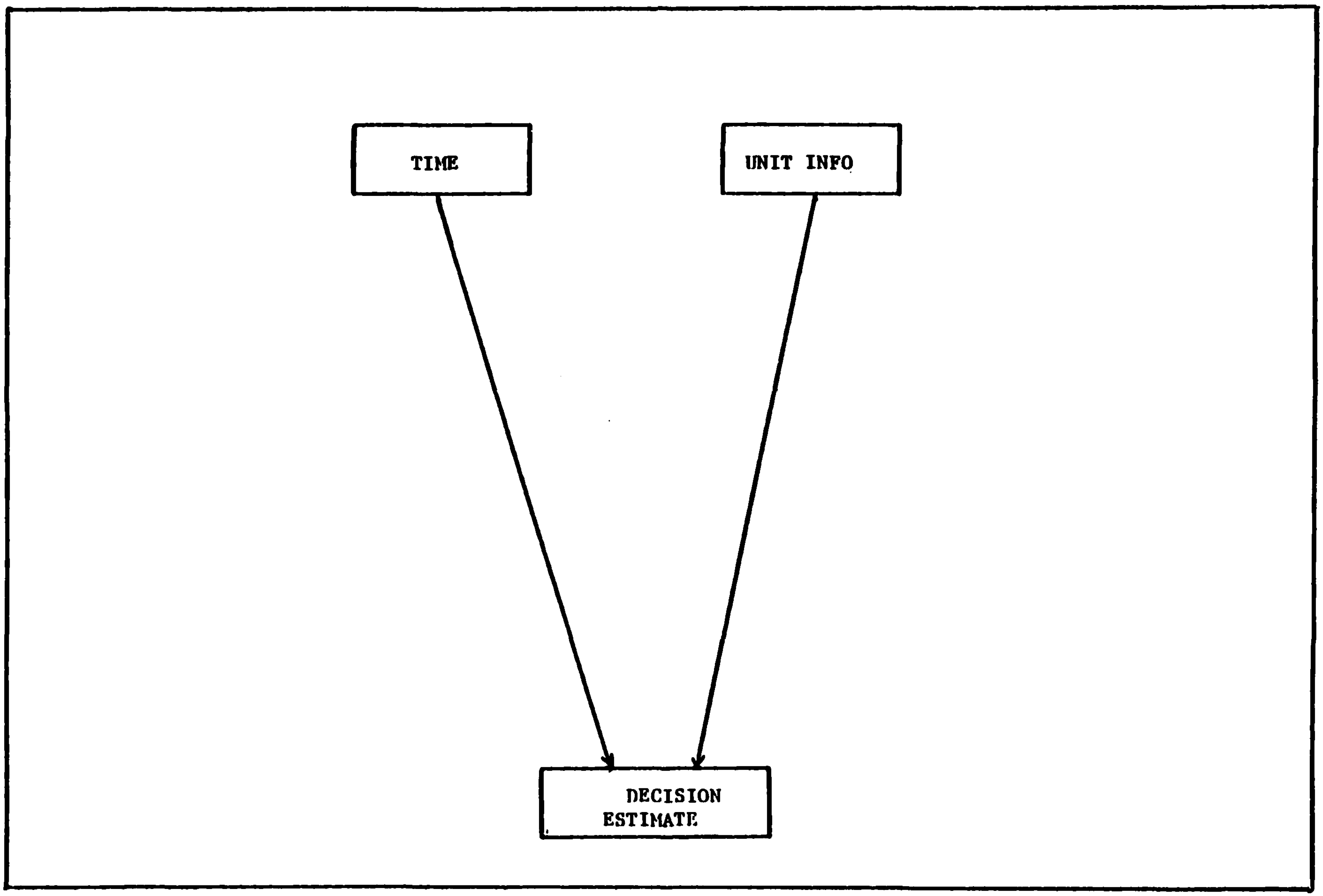


Figure L-3. Logical Schema (Network) Diagram : Tactical Decisions

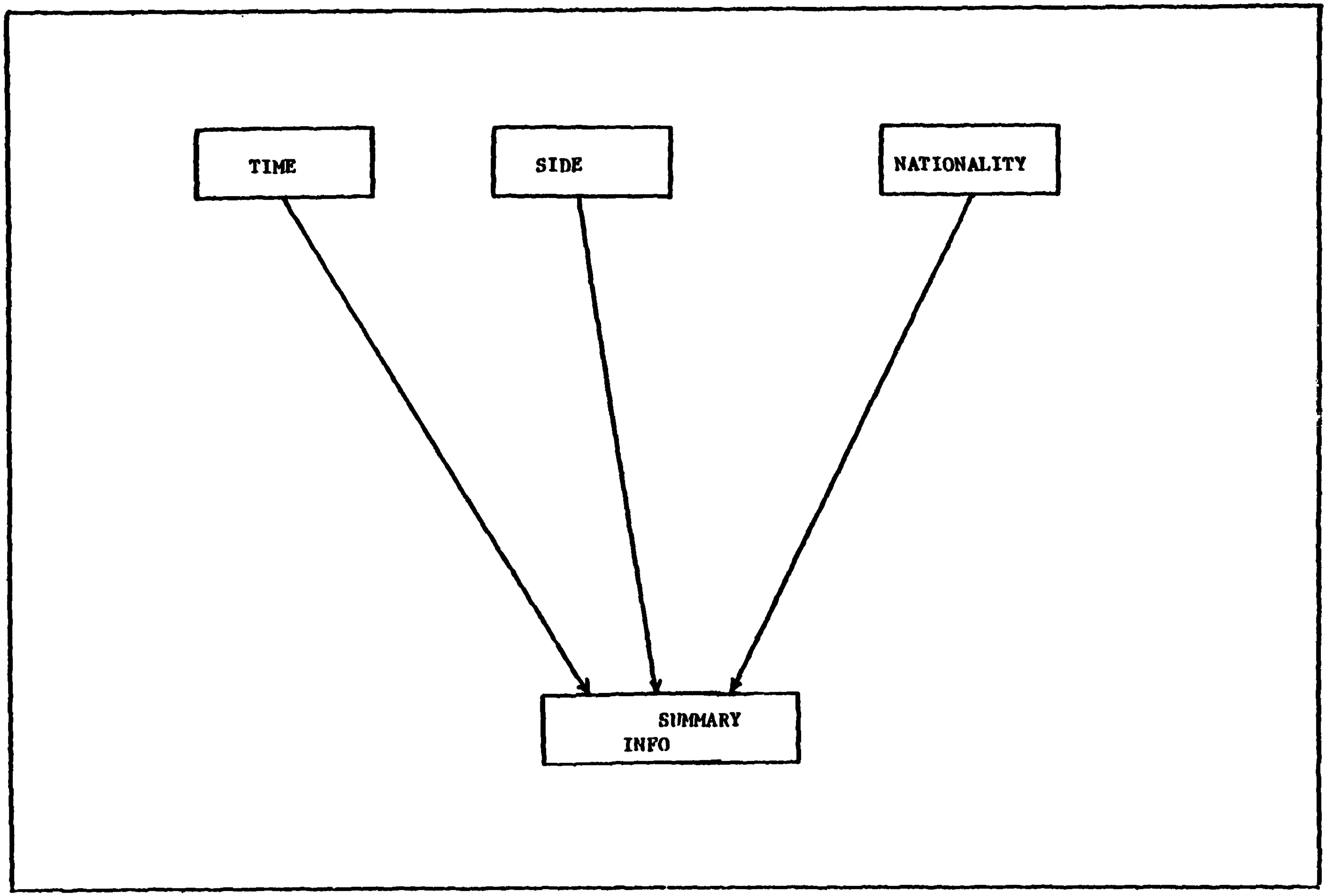


Figure L-4. Logical Schema (Network) Diagram : War Summary

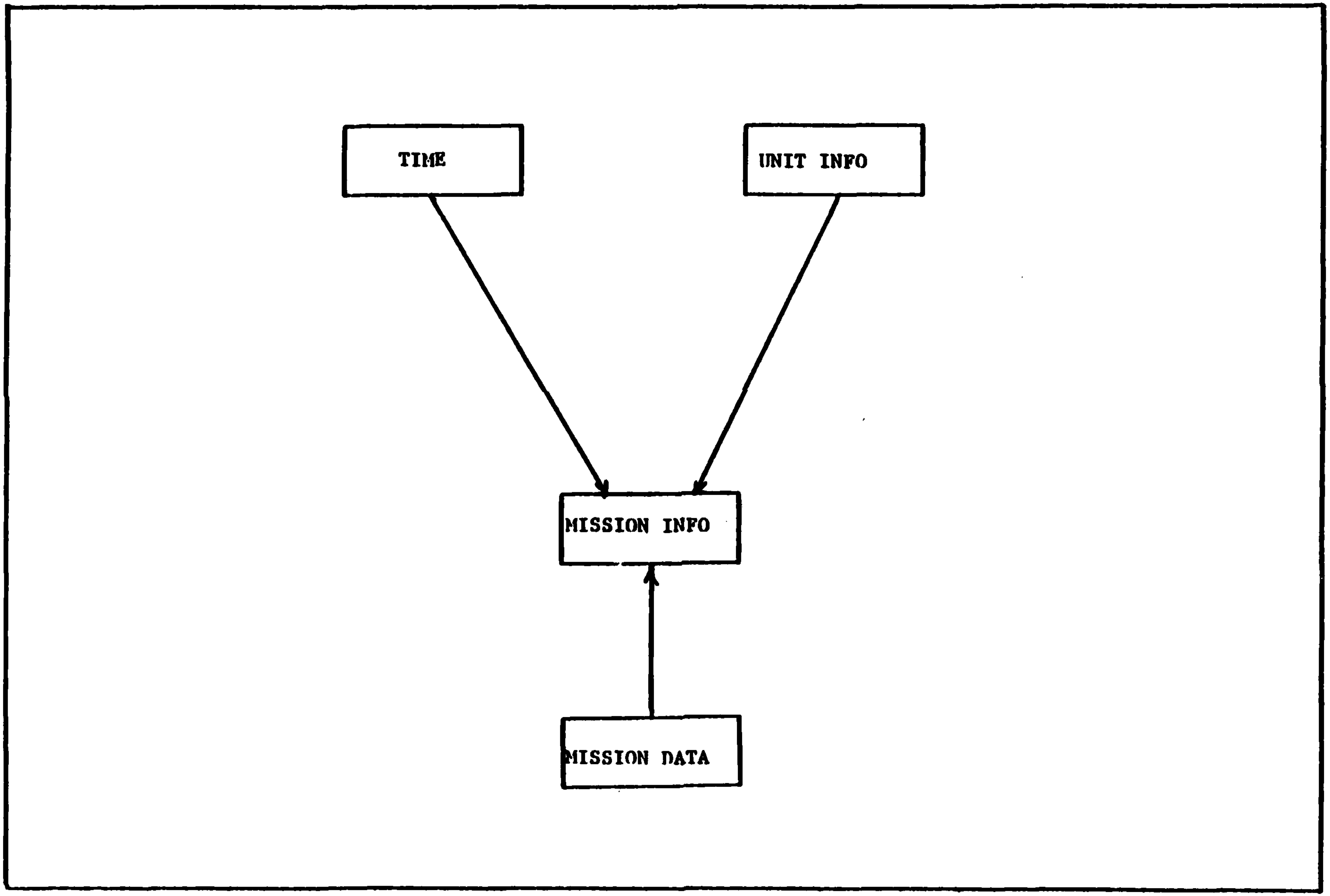


Figure L-5. Logical Schema (Network) Diagram : Mission

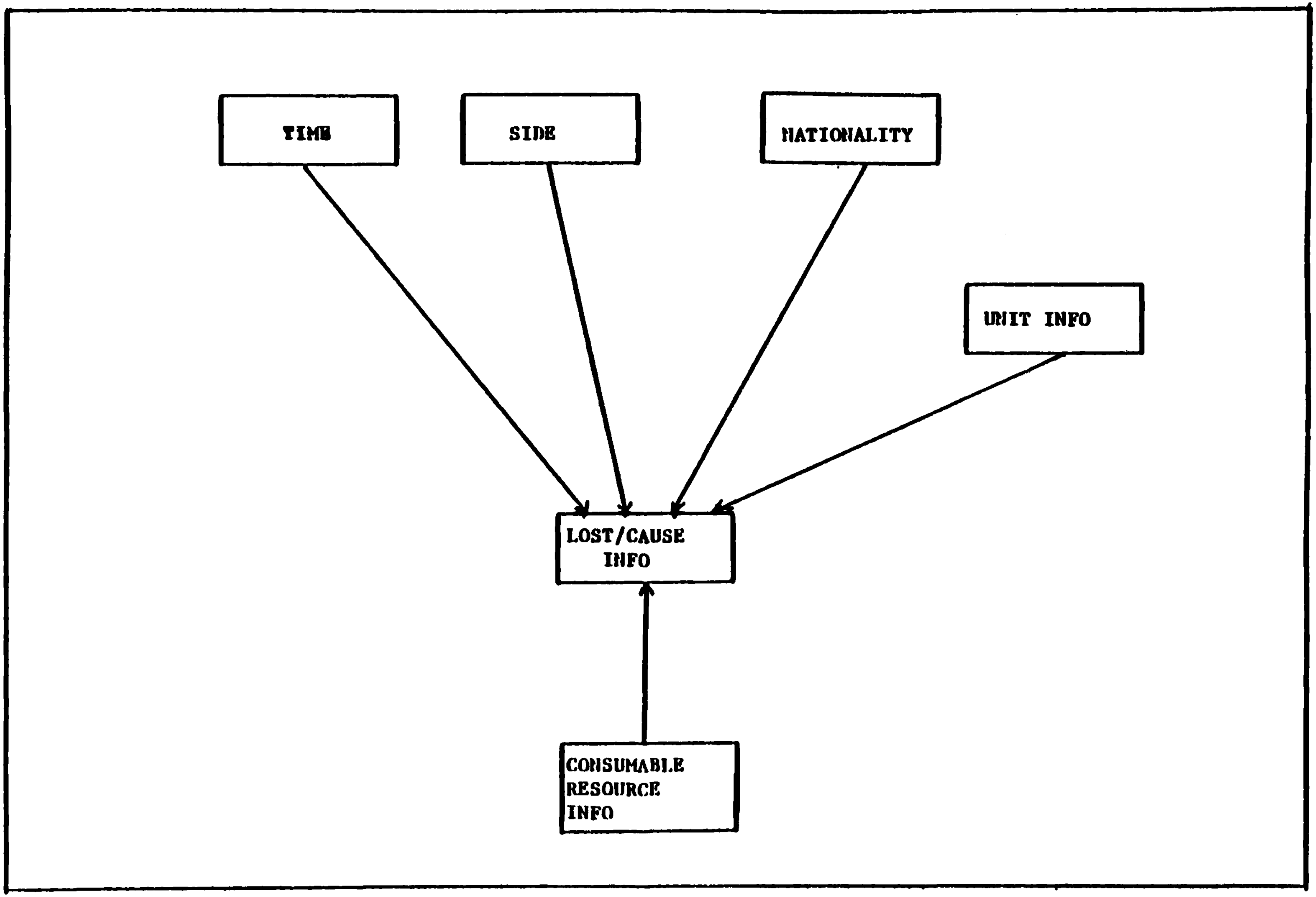


Figure L-6. Logical Schema (Network) Diagram : Logistics Lost/Cause

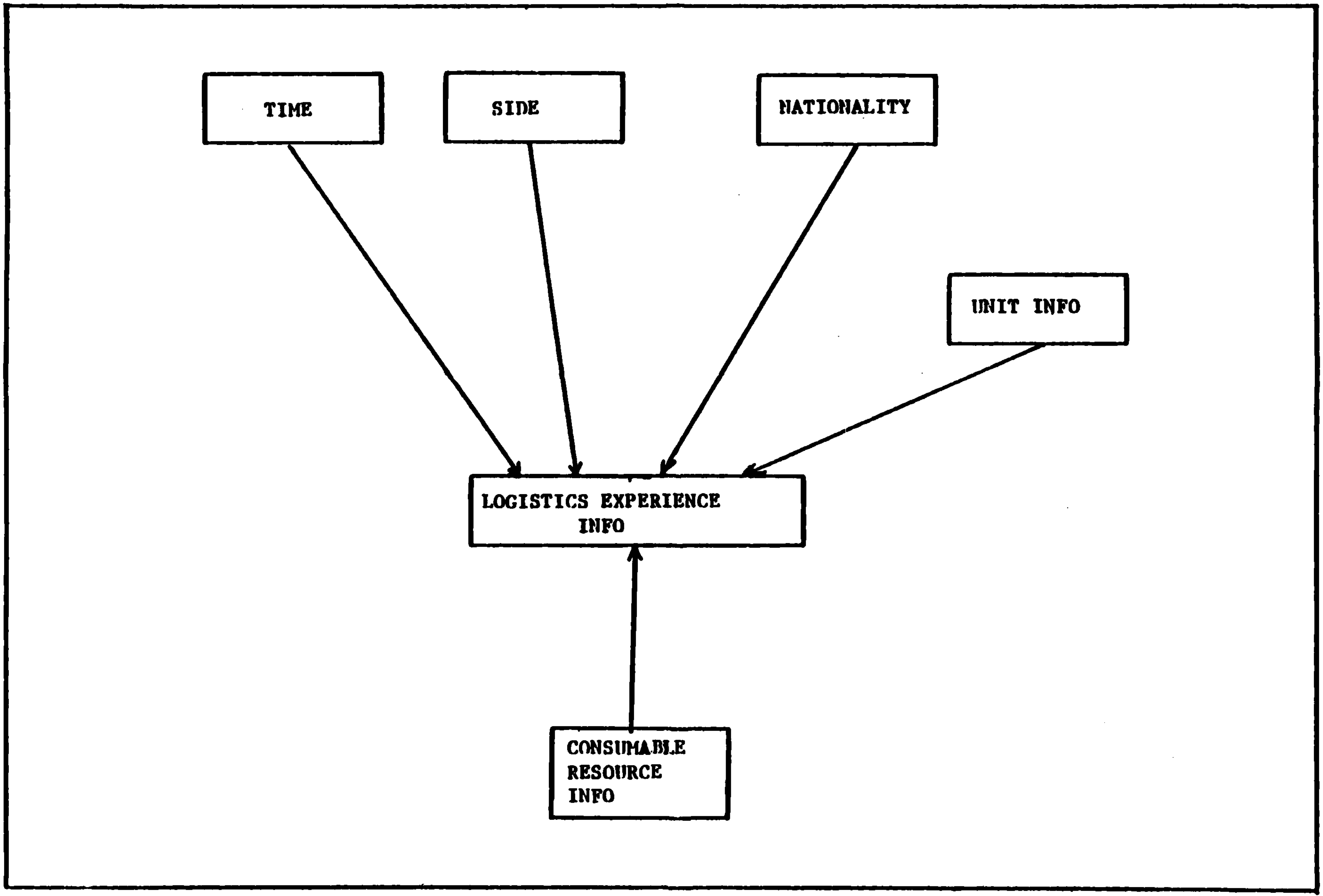


Figure L-7. Logical Schema (Network) Diagram : Logistics Experience

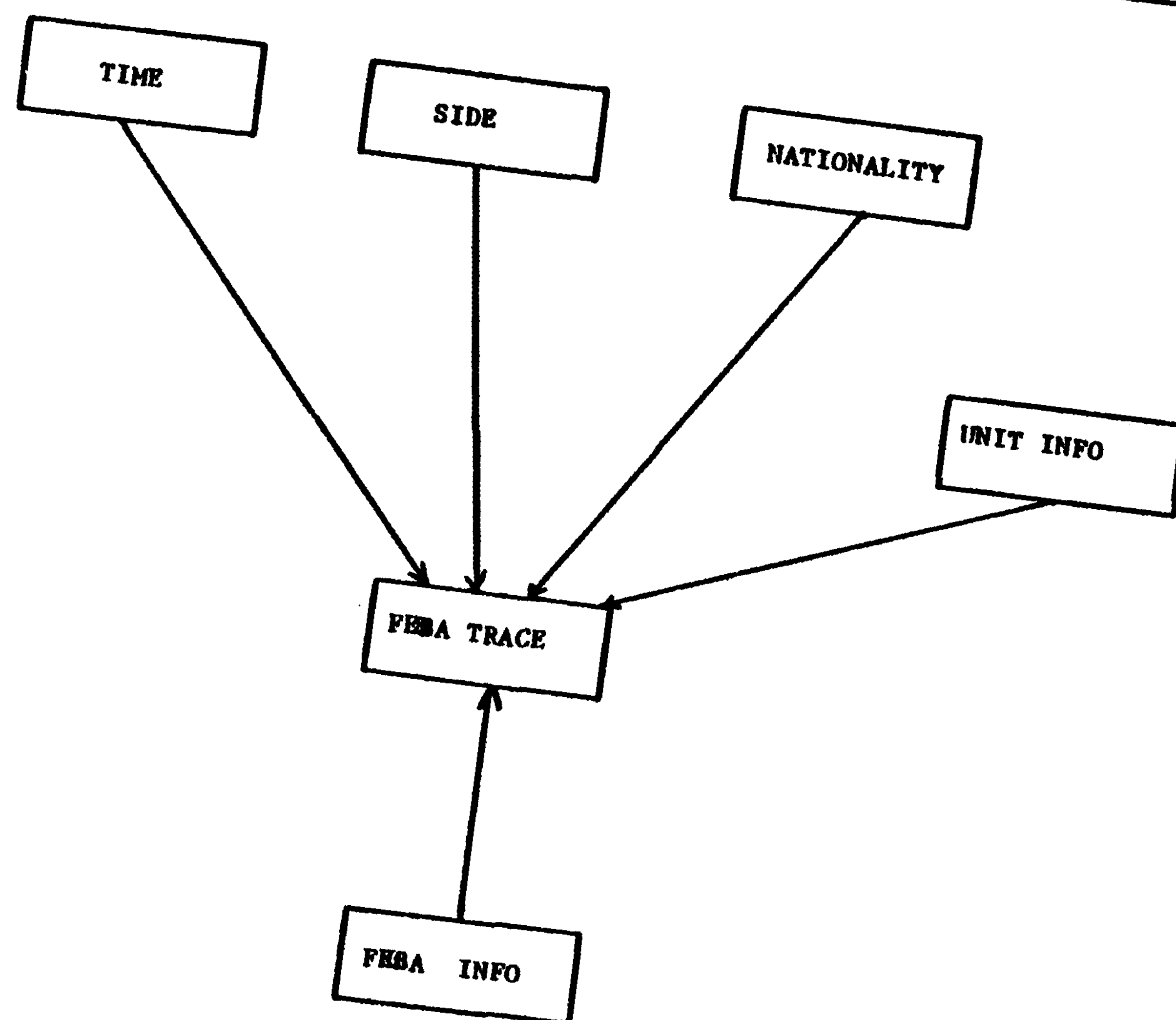


Figure L-8. Logical Schema (Network) Diagram : FEBA Data

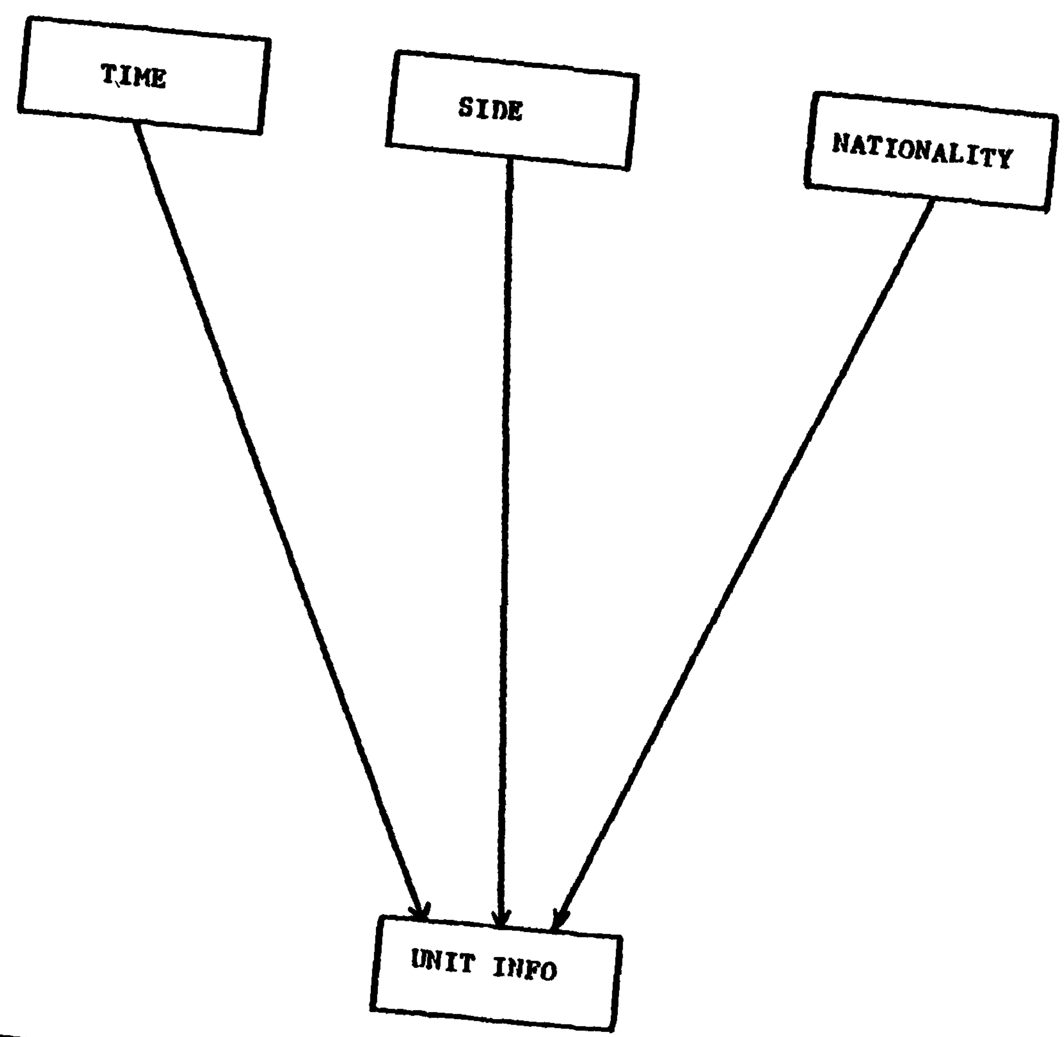


Figure L-9. Logical Schema (Network) Diagram : Unit Data

Appendix M

Records and Sets

Records annotated with a "*" indicates a connector record. A connector record, with no data fields, equates the number of pointers to "# of characters/record". This is to preclude the impression that a connector record has no storage requirements associated with it. In the records containing data fields, the pointers are not included in the character count.

RECORDS	# OF CHARACTERS/RECORDS
RECORD NAME IS UNIT INFO	
Unit Name	50
Unit Type	10
Echelon	10
Authorized Strength	6
RECORD NAME IS MISSION DATA	
Mission Type	10
RECORD NAME IS MISSION INFO *	
All Pointers	3
RECORD NAME IS TIME	
Theater Cycle	3
RECORD NAME IS SUMMARY INFO	
FEBA Change	6
# In-Theater Divisions	4
# In-Theater Aircraft	4
# In-Theater GS Arty	4
# In-Theater CAS	4
# Tons Arty Ammo Expended	8
# Decimated Divisions	4
RECORD NAME IS NATIONALITY	
Nationality Type	25
RECORD NAME IS SIDE	
Side Type	4
RECORD NAME IS DECISION ESTIMATE	
Friendly FP #	5
Enemy FP #	5
Force Ratio	5
Current Posture	6
Decision	10
RECORD NAME IS FEBA TRACE *	
All Pointers	4

RECORD NAME IS FEBA INFO

Minisector Value	3

RECORD NAME IS CONSUMABLE RESOURCE INFO

Resource Item	25
Resource Category	10

RECORD NAME IS LOGISTICS EXPERIENCE INFO *

# Authorized	5
# On-Hand	5
# Gains to Theater Stock - Resupply	6
# Gains to Theater Stock - Repair	6
# Items in Repair	6
# Items Lost to Combat	6
# Items Temp Lost to Non-Combat	6
# Items Perm Lost to Non-Combat	6
# Items Lost to Maintenance	6

RECORD NAME IS LOST/CAUSE INFO *

# Items Engaged	6
# Hit by Tank	6
# Hit By APC	6
# Hit by AT/M	6
# Hit by HELOS	6
# Hit by ARTY	6
# Hit by CAS	6

RECORD NAME IS AIR INFO

# Primary TAC Fighters	4
# Sanctuary TAC Fighters	4
# A/D Fighters	4
% TAC Fighters AR/I	2
% TAC Fighters CA	2
% TAC Fighers CAS	2
# Primary Aircraft Destroyed - Ground	4
# Aircraft Destroyed	5

RECORD NAME IS CASUALTY INFO

# Infantry Engaged	6
# Infantry KIA	6
# Infantry CMIA	6
# Crews Engaged	6
# Crews KIA	6
# Crews WIA	6
# Casualties DNBI	6
# Casualties DNBIK	6
# Casualties Hospital	6
# Casualties Evacuated	6

SETS

```
SET NAME IS CASUALTIES BY TIME
     OWNER IS TIME
     MEMBER IS CASUALTY INFO

SET NAME IS CASUALTIES BY SIDE
     OWNER IS SIDE
     MEMBER IS CASUALTY INFO

SET NAME IS CASUALTIES BY NATIONALITY
     OWNER IS NATIONALITY
     MEMBER IS CASUALTY INFO

SET NAME IS UNIT CASUALTIES
     OWNER IS UNIT INFO
     MEMBER IS CASUALTY INFO

SET NAME IS THEATER AIR FORCE
     OWNER IS TIME
     MEMBER IS AIR INFO

SET NAME IS OPPOSING AIR FORCES
     OWNER IS SIDE
     MEMBER IS AIR INFO

SET NAME IS NATIONALITY AIR FORCES
     OWNER IS NATIONALITY
     MEMBER IS AIR INFO

SET NAME IS UNIT AIR FORCES
     OWNER IS UNIT
     MEMBER IS AIR INFO

SET NAME IS THEATER LOGISTICS LOST/CAUSE
     OWNER IS TIME
     MEMBER IS LOST/CAUSE INFO

SET NAME IS OPPOSING FORCES LOGISTICS LOST/CAUSE
     OWNER IS SIDE
     MEMBER IS LOST/CAUSE INFO

SET NAME IS NATIONALITY LOGISTICS LOST/CAUSE
     OWNER IS NATIONALITY
     MEMBER IS LOST/CAUSE INFO

SET NAME IS UNIT LOGISTICS LOST/CAUSE
     OWNER IS UNIT INFO
     MEMBER IS LOST/CAUSE INFO

SET NAME IS RESOURCE LOST/CAUSE
     OWNER IS CONSUMABLE RESOURCE INFO
     MEMBER IS LOST/CAUSE INFO
```

```
SET NAME IS THEATER LOGISTICS EXPERIENCE
     OWNER IS TIME
     MEMBER IS LOGISTICS EXPERIENCE INFO

SET NAME IS OPPOSING FORCES LOGISTICS EXPERIENCE
     OWNER IS SIDE
     MEMBER IS LOGISTICS EXPERIENCE INFO

SET NAME IS NATIONALITY LOGISTICS EXPERIENCE
     OWNER IS NATIONALITY
     MEMBER IS LOGISTICS EXPERIENCE INFO

SET NAME IS UNIT LOGISTICS EXPERIENCE
     OWNER IS UNIT INFO
     MEMBER IS LOGISTICS EXPERIENCE INFO

SET NAME IS RESOURCE LOGISTICS EXPERIENCE
     OWNER IS CONSUMABLE RESOURCE INFO
     MEMBER IS LOGISTICS EXPERIENCE INFO

SET NAME IS FEBA TRACE BY TIME
     OWNER IS TIME
     MEMBER IS FEBA TRACE

SET NAME IS FEBA TRACE BY OPPOSING FORCES
     OWNER IS SIDE
     MEMBER IS FEBA TRACE

SET NAME IS FEBA TRACE BY NATIONALITY
     OWNER IS NATIONALITY
     MEMBER IS FEBA TRACE

SET NAME IS FEBA TRACE BY UNIT
     OWNER IS UNIT INFO
     MEMBER IS FEBA TRACE

SET NAME IS FEBA VALUES
     OWNER IS FEBA INFO
     MEMBER IS FEBA TRACE

SET NAME IS THEATER UNITS
     OWNER IS TIME
     MEMBER IS UNIT INFO

SET NAME IS FORCE UNITS
     OWNER IS SIDE
     MEMBER IS UNIT INFO

SET NAME IS UNITS NATIONALITY
     OWNER IS NATIONALITY
     MEMBER IS UNIT INFO
```

```
SET NAME IS UNIT DECISION INFO
     OWNER IS UNIT INFO
     MEMBER IS DECISION ESTIMATED

SET NAME IS THEATER DECISION ESTIMATE
     OWNER IS TIME
     MEMBER IS DECISION ESTIMATE

SET NAME IS THEATER SUMMARY
     OWNER IS TIME
     MEMBER IS SUMMARY INFO

SET NAME IS THEATER FORCES SUMMARY
     OWNER IS SIDE
     MEMBER IS SUMMARY INFO

SET NAME IS NATIONALITY THEATER SUMMARY
     OWNER IS NATIONALITY
     MEMBER IS SUMMARY INFO

SET NAME IS THEATER MISSIONS
     OWNER IS TIME
     MEMBER IS MISSION INFO

SET NAME IS UNIT MISSIONS
     OWNER IS UNIT INFO
     MEMBER IS MISSION INFO

SET NAME IS MISSION DECISIONS
     OWNER IS MISSION INFO
     MEMBER IS MISSTION DATA
```

Appendix N

Database Size Estimations

This appendix attempts to estimate the storage requirements for each of the logical databases designed in this thesis investigation. Size estimates are based upon the number of occurrences of each record type and the size (# of characters per record occurrence). Storage requirements for pointers are not included in the estimate, except for those connector records that contain only pointers (reference Appendix M).

CASUALTIES

(360 Time Recs * 3 chars/rec) + (2 Side Recs * 4 chars/rec)
+ (4 Nationality Recs * 25 chars/rec) +
(1350 Unit Info Recs * 76 chars/rec) +
(3888 K Casualty Info recs * 60 chars/rec)

= 233,383,000 characters

FEBA DATA

(360 Time Recs * 3 chars/rec) + (2 Side Recs * 4 chars/rec)
+ (4 Nationality Recs * 25 chars/rec) +
(1350 Unit Info Recs * 76 chars/rec) +
(600 FEBA Info Recs * 3 chars/rec) +
(3888 K FEBA Trace Recs * 4 chars/rec)

= 15,657,588 characters

TACTICAL AIR

(360 Time Recs * 3 chars/rec) + (2 Side Recs * 4 chars/rec)
+ (4 Nationality Recs * 25 chars/rec) +
(1350 Unit Info Recs * 76 chars/rec) +
(3888 K Air Info Recs * 31 chars/rec)

= 120,634,000 characters

TACTICAL DECISIONS

(360 Time Recs * 3 chars/rec) +
(1350 Unit Info Recs * 76 chars/rec) +
(486,000 Decision Estimate Recs * 31 chars/rec)

= 15,169,700 characters

WAR SUMMARY

(360 Time Recs * 3 chars/rec) + (2 Side Recs * 4 chars/rec)
+ (4 Nationality Recs * 25 chars/rec) +
(2880 Theater Summary Info Recs * 34 chars/rec)

= 99,108 characters

UNIT DATA
(360 Time Recs * 3 chars/rec) + (2 Side Recs * 4 chars/rec)
+ (4 Nationality Recs * 25 chars/rec) +
(1350 Unit Info Recs * 76 chars/rec)

= 108,788 characters

MISSION
(360 Time Recs * 3 chars/rec) +
(4 Mission Data Recs * 10 chars/rec) +
(1350 Unit Info Recs * 76 chars/rec)
(486,000 Mission Info Recs * 3 chars/rec)

= 1,561,720 characters

LOGISTICS LOST/CAUSE
(360 Time Recs * 3 chars/rec) + (2 Side Recs * 4 chars/rec)
+ (4 Nationality Recs * 25 chars/rec) _
(1350 Unit Info Recs * 76 chars/rec) +
(50 Consumable Resource Info Recs * 35 chars/rec) +
(194,400 K Logistics Lost/Cause Info Recs * 42 chars/rec)

= 8,164,904,000 characters

LOGISTICS EXPERIENCE
(360 Time Recs * 3 chars/rec) + (2 Side Recs * 4 chars/rec)
+ (4 Nationality Recs * 25 chars/rec) _
(1350 Unit Info Recs * 76 chars/rec) +
(50 Consumable Resource Info Recs * 35 chars/rec) +
(194,400 K Logistics Experience Info Recs * 52 chars/rec)

= 10,088,104,000 characters

Appendix O

Transport Volume

Calculation of transport volume allows one to assess the amount of data flowing between the DBMS and a specific database transaction. Specification of sample transactions is accomplished through the use of a pseudo data manipulation language (DML) similar to the one encountered on the DMS-1100. This appendix takes the sample transactions, relating to the data processing requirements in Appendix I, and demonstrates the corresponding transport volume. This performance measurement can be used to refine or alter the logical schemas to better satisfy the user's informational requirements (Ref 13:187).

TRANSACTION : List the number of infantry KIA where theater cycle = 3 and unit name = 3rd Tank Corps.

SUBJECT DATABASE : Casualties

LOGICAL RECORDS ACCESSED : 1 TIME + 1 UNIT INFO + 1 CASUALTY INFO

TRANSPORT VOLUME/TRANSACTION : 139 chars

FREQUENCY OF TRANSACTION : 10/day

TRANSPORT VOLUME/DAY : 1390 chars/day

TRANSACTION : List the unit name and the high and low minisector values where side = blue.

SUBJECT DATABASE : FEBA Data

LOGICAL RECORDS ACCESSED : 1350 UNIT INFO + 1 SIDE + 1350 FEBA TRACE + 1350 FEBA INFO

TRANSPORT VOLUME/TRANSACTION : 112,054 chars

FREQUENCY OF TRANSACTION: 5/day

TRANSPORT VOLUME/DAY : 560,270 chars/day

TRANSACTION : List the number of aircraft destroyed where theater cycle = 1 and side = blue and nationality = French and unit name = 3rd Air Force.

SUBJECT DATABASE : Tactical Air

LOGICAL RECORDS ACCESSED : 1 TIME + 1 SIDE + 1 NATIONALITY + 1 UNIT INFO

TRANSPORT VOLUME/TRANSACTION : 108 chars

FREQUENCY OF TRANSACTION : 1500/day

TRANSPORT VOLUME/DAY : 162,000 chars/day

TRANSACTION : List the decision where theater cycle = 1 - 100 and unit name = 11th Infantry Division.

SUBJECT DATABASE : Tactical Decisions

LOGICAL RECORDS ACCESSED : 1 UNIT INFO + 100 TIME + 100 DECISION ESTIMATE

TRANSPORT VOLUME/TRANSACTION : 3476 chars

FREQUENCY OF TRANSACTION : 2/day

TRANSPORT VOLUME/DAY : 6952 chars/day

TRANSACTION : List the unit type where side = blue and unit name 24th Army.

SUBJECT DATABASE : Unit Data

LOGICAL RECORDS ACCESSED : 1 SIDE + 1 UNIT INFO

TRANSPORT VOLUME/TRANSACTION : 80 chars

FREQUENCY OF TRANSACTION : 100/day

TRANSPORT VOLUME/DAY : 8000 chars/day

TRANSACTION : List the number of in-theater divisions
where nationality = Non-US NATO.

SUBJECT DATABASE : War Summary

LOGICAL RECORDS ACCESSED : 1 NATIONALITY + 10 THEATER SUMMARY

TRANSPORT VOLUME/TRANSACTION : 365 chars

FREQUENCY OF TRANSACTION : 350/day

TRANSPORT VOLUME/DAY : 127,750 chars/day

TRANSACTION : List the mission where unit name = 11th Armor
and theater cycle = 360.

SUBJECT DATABASE : Mission

LOGICAL RECORDS ACCESSED : 1 UNIT INFO + 1 TIME
+ MISSION INFO

TRANSPORT VOLUME/TRANSACTION : 82 chars

FREQUENCY OF TRANSACTION : 3000/day

TRANSPORT VOLUME/DAY : 246,000 chars/day

TRANSACTION : List the number of XM-1 tanks hit by APC's
where resource item = XM-1 and side = blue
and theater cycle = 2 and nationality = US.

SUBJECT DATABASE : Logistics Lost/CAuse

LOGICAL RECORDS ACCESSED : 1 TIME + 1 SIDE + 1 NATIONALITY
+ 1 CONSUMABLE RESOURCE INFO

TRANSPORT VOLUME/TRANSACTION : 67 chars

FREQUENCY OF TRANSACTION : 50/day

TRANSPORT VOLUME/DAY : 3350 chars/day

TRANSACTION : List the number of items in repair
where resource item = XM-1 and
theater cycle = 1 - 600.

SUBJECT DATABASE : Logistics Experience

LOGICAL RECORDS ACCESSED : 600 TIME + 1 CONSUMABLE RESOURCE INFO
+ 600 Logistics Experience Info

TRANSPORT VOLUME/TRANSACTION : 33,035 chars

FREQUENCY OF TRANSACTION ; 3/day

TRANSPORT VOLUME/DAY : 99,105 chars/day

Appendix P

Glossary of Acronyms and Abbreviations
(Ref 8,9,17,18)

A/D	Air Defense
AFPDA	Armed Forces Planning Document
AMMO	Ammunition
AMSAA	Army Material Systems Analysis Activity
APC	Armored Personnel Carrier
ARSTAFF	Army Staff
AR/I	Air Reconnaissance/Interdiction
ARTY	Artillery
AT/M	Anti-Tank/Mortar
Bn	Battalion
CA	Counter Air
CAA	Concepts Analysis Agency (short USACAA)
CAS	Close Air Support
CEM V	Concepts Evaluation Model - revision #5
chars	Characters
chars/rec	Characters/Record
chars/day	Characters/Day
CMIA	Captured or Mission in Action
DBMS	DataBase Management System
DBNI	Disease, Non-Battle Injury
DBNIK	Disease, Non-Battle Injury Killed
DCSOPS	Deputy Chief of Staff for Operations and Plans
DFD	Data Flow Diagram
DIPD	Defense Intelligence Planning Document

DML	Data Manipulation Language
DMS-1100	DBMS used AT USACAA
FEBA	Forward Edge of the Battle Area
FP	Fire Power
HELOS	Helicopters
IDOFOR	Improving the Definition of the Objective Force Study Team
JSPD	Joint Strategic Planning Document
Log	Logistics
KIA	Killed In Action
Nation	Nationality
NATO	North Atlantic Treaty Organization
OMNIBUS	US Army Operational Readiness Analysis Study Team
Opp	Opposing
recs	Records
RQ	Requirements Study Team
TAA	Total Army Analysis Study Team
TAC	Tactical Air Command
tech	Technical
TOE	Table of Organization and Equipment
USACAA	United States Army Concepts Analysis Agency
SADT	Structured Analysis Design Technique
WIA	Wounded In Action

Vita

John D. Hightower was born on 06 February 1955 in Denver, Colorado. He graduated from high school in Golden, Colorado in 1973 and attended the United States Military Academy from which he received the degree of Bachelor of Science in June 1977. Upon graduation he was commissioned in the United States Army and was stationed at Fort Huachuca, Arizona. Prior to entering the School of Engineering, Air Force Institute of Technology in September of 1981, he served as Commander of the 505th Signal Company, 86th Signal Battalion, 11th Signal Brigade (United States Army Communications Command).

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19. KEY WORDS (Continue on reverse side if necessary and identify by block number)

Logical Database Design
Concepts Evaluation Model

20. ABSTRACT (Continue on reverse side if necessary and identify by block number)

A systems analysis was performed on the Threat Force File development process used in conjunction with the Concepts Evaluation Model (CEM V) at the United States Army Concepts Analysis Agency. Additionally, logical subject databases were designed to facilitate the retrieval of specific information from the output generated by the CEM V. A systematic approach provided the focus for resolution of each activity.

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The resulting systems analysis documents the activities and processes that the agency's four major study teams go through in preparing the Threat Force File for input to the CEM V. Areas were identified for application of data management techniques to improve system efficiency.

The database designs resulted from the application of techniques selected from existing design methodologies. The logical schemas were transformed into network structures consistent with the database management system (DMS-1100) used by USACAA.

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